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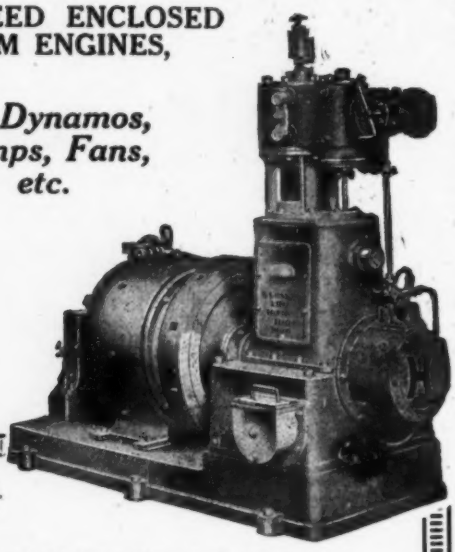

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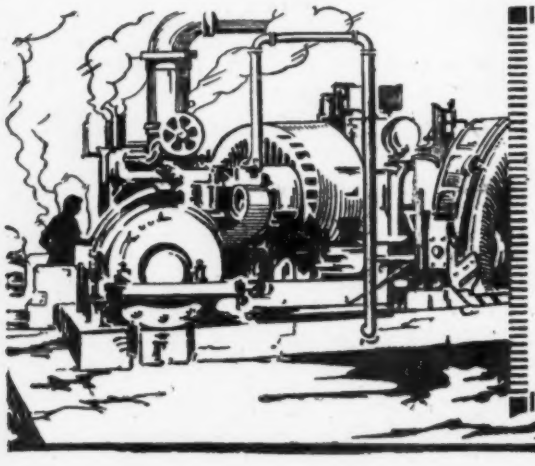

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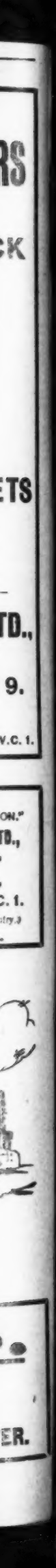

THE
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## THE COMMON GOOD.

APPEARING as we do practically on the Eve of Christmas, it is impossible to rid ourselves of the great human problem that overhangs the nation. Behind all our seasonable good wishes and apparent cheerfulness there lies the knowledge that there are between a million and a million-and-a-half of our fellow-subjects without any work to do. In addition, there is a continuous exodus from the schools of boys and girls whose elementary education, at least, is finished, and to quote a leader in Social Work there are two hundred thousand of them between the school-leaving age and 18 with idle hands at a period when minds are most impressionable and character is formed or set. What is to become of them while we await the revival of trade?

All classes in the community deplore the "dole," as it is called—thousands of those who draw it deplore it quite as keenly as, and sometimes more so than, those who feel the burden of paying it. But nobody holds that unemployment pay can be stopped and thousands be allowed to starve because it has defied our efforts to find enough work to go round.

Here we have nothing whatever to do with politics as such, but we say unhesitatingly that the future of any one of the three parties is a matter of far less consideration than is the future of industry, trade, and other means for affording employment. The concern of the three parties should not be: which can turn the others out with the best subsequent advantage to itself? but: how can we all contribute to the well-being of the entire community?

The programmes of the respective parties with their vague generalities as they were placed before the electorate lie before us. In the present state of affairs they stand for little, but does it lie beyond us to bring the best minds and the most experienced advisers to concentrate thought and effort upon all practical points in which there is likelihood of compromise being reached and progress made? A beginning could be made by the elimination of all that was mere wordiness or elusive soap-bubble colouring, all mere vote-catching generalities. What remained of really constructive value could and should be carried into effect without waiting until this winter is past.

Such reflections as the foregoing must possess the minds of large numbers of our readers as we stand at the season of the festival of festivals when to so many households the wish "A Merry Christmas" can be little more than a mockery. May we hope that the spirit of Christmas will arouse feelings of sympathetic anxiety in all in whom is vested responsibility and influence in the promotion of Peace, Goodwill, and united action for the good of all?

The electrical industry has not been passing through so serious a period of inactivity as has fallen to some other branches. Those connected with it can greet each other with the old familiar wish both for Christmas and the New Year. Its scope for development is great, the productive ability of its works would enable it to absorb many thousands of additional workers, and the outlook is satisfactory unless the demand for British work to be carried out by British workpeople be weakened or replaced. There is a greater self-preservative and development force within the industry than perhaps ever before, and we may look to this to assist to avert

dangerous developments from abroad. The benefit of the works planned last autumn is beginning to make itself felt in the factories, and the placing of contracts for big railway schemes, such as the L.M. & S.R. fourteen million sterling developments, in different parts of the country, must improve the situation early in the New Year, for electrical, engineering, and contracting works alike. If there were less obscurity regarding the general situation a more confident outlook might release other orders.

While electrically we are not disheartened with regard to the situation of affairs, we deplore the depression in many other trades, and appeal to those who have it in their power to show timely generosity to those who through no fault of their own are less fortunate. We also hope that our legislators may exercise wisdom, and that amongst the people there may be more of the non-party spirit and more of the impulse for the common good.

---

**The Quantum Theory.**

As physicists press forward into the vast fields of research that were thrown open when the master-key which gave admittance to them was discovered—namely, radium and all the astonishing phenomena which it connotes—new and strange facts confront the explorers, so strange indeed that at first their existence is hardly credible. (We use the word "facts" in the human sense, meaning the fruits of experience and observation, and we do not pretend that the best of our facts may not eventually be proved by later discoveries to be fallacious. But until then they hold the field.)

One of the most startling of these discoveries is that embodied in the theory of the "quantum," which states that light and energy, which we have believed to be continuously divisible *ad infinitum*, can be produced or radiated only in parcels of rigidly-defined magnitude. To use a homely simile, they are not like syrup, but like lump sugar; more correctly, they are more like finely crystallised sugar. Each parcel is infinitesimal, and is known as a "quantum."

Four years ago, when everyone was speaking of "relativity" and asking what it all meant, Mr. R. W. Western wrote for us a simple explanation of Einstein's theory, so far as it could be expressed in words; he has now again come to the rescue with an explanation of the quantum theory and some of its consequences, and we commend his article, which is concluded in this issue, to the attention of readers who wish to acquire a clear conception of the principle involved—reminding them that what we regard to-day as "high-brow" theory may not improbably be every-day practice next year.

---

**Australian Industries.**

At the close of the Imperial Economic Conference it was felt that one of the most important proposals affecting the industries of the United Kingdom was the decision in favour of the Government offering financial facilities to encourage the early carrying out of Dominion and Colonial public utility and other undertakings. It was supposed that this would be one of the quickest means for bringing work to our factories and lessening unemployment at the lowest cost. It is now reported by cable from Melbourne that the Victorian Government has rejected the Imperial Government's offer on the ground that first preference must be given to Australian manufactures. Natural as this may appear, it is of course not encouraging to the British trader, but for several years past Australia has been setting up new industries and still is seeking to establish others, especially within easy reach of electric power from Morwell. There are powerful interests in Australia which seek to render these industries secure, but time alone will declare whether such a policy can be profitably continued while markets are so limited and production is comparatively small. Australian students of the situation are complaining that the high rates of wages ruling there place Colonial manufacturing at a serious disadvantage when engineering and other wages are low at Home. Business-men, too, are trying to expand Australian export trade in markets near at hand and so to increase production, thus reducing the cost of the individual article, but whatever happens, we are faced with the frank rejection by Victoria of the Mother Country's pre-election offer of financial assistance for the development of works which would have produced employment for British labour in the British Empire.

---

**Trade with South America.**

Representatives of the Federation of British Industries have been touring the South American Republics recently investigating the possibilities of the markets out there and establishing personal touch. On October 25th at Buenos Aires a luncheon was given in their honour by the local British Chamber of Commerce. Mr. Locock and Mr. Rouse, the F.B.I. representatives, placed themselves at the disposal of business-men and invited suggestions calculated to foster trade. According to the *Bulletin* of the Federation, Mr. E. A. Woodward, on behalf of the British Chamber, emphasised the importance in dealing with the Argentine, of careful inquiry into the needs of the buyer and of supplying the right goods at the right price. Mr. Locock is paying a visit to Cuba on his way home, but Mr. Rouse is remaining in South America for some time to confer with commercial interests in the various centres. This is an extremely important department of F.B.I. activities. The more representatives of British manufacturers and traders get abroad just now—whether as agents of big organisations or as travellers for individual electrical and engineering businesses—the more hopeful will the export trade and Home employment situation become. If the man who makes two blades of grass grow where there was only one is deserving of praise, then the men who can bring in export business of greater volume and speed-up the wheels of industry are public benefactors.

The activity of Continental traders in South America has been pressed upon our notice with urgency of late. It is the more gratifying to record the operations of the Federation on behalf of British interests.

---

**Chinese Disorder and Trade.**

The least unsatisfactory feature of the trade situation in China, according to the report of the Commercial Secretary (Mr. H. J. Brett) up to June last, is that Great Britain's share is being fairly well maintained and that British goods are holding their own in competition with those from other countries. In the trades which have a special interest for British manufacturers, *i.e.*, cotton piece goods and machinery, competition tends to increase from Japan and the native mills on the one hand and from the United States and Germany on the other, but Mr. Brett finds no evidence that our strong position in these lines is seriously threatened yet.

Mr. Brett refers to the need for the restoration of ordered Government, a need which certainly has not lessened since his report was written. His statement is that all that can be hoped is that the efforts of British manufacturers and merchants will be successful in securing their fair share of the limited business possible under existing conditions. May one not hope, in addition, that the efforts of the British and other Governments whose subjects have risked and are still risking life and property in China will soon be successful in securing some guarantee of safety against brigandage? The threats of Sun Yat Sen have compelled the Powers to take action to deal with the menace. The situation is certainly one calling for a strong and discreet policy, and we hope that even the limited action so far taken will have a healthy effect, but where so many interests and rival factions are engaged, one despairs of an early widespread quiescence taking the place of general turbulence.

**The "U Boats" and Norwegian Electricity Works.**

It was mentioned in this journal a few months ago that many communal electricity works in Norway were unable to pay interest on the loans raised for these works or to redeem the debt, owing to the works having been established at the high prices which prevailed for machinery and plant during the war. Naturally the question arises why the works should have been undertaken under the influence of such a state of affairs, seeing that it would have been cheaper to wait until the end of the period of hostilities. The explanation lies in the fact, which has just been revealed in the course of a report presented to the Norwegian Parliament, of the then existence of submarine boat warfare. The fear of a scarcity of coal and of petroleum, it is stated, brought about partial "panic work" in many communes in the matter of the electrification of their districts. The high expenditure which was incurred under these circumstances has since placed a number of the communes in financial difficulties in so far as their electricity works are concerned. As a consequence, it has been necessary for the communes in question to apply to the Government for financial assistance, which is now to be given. A committee of the Norwegian Storthing, in approving a departmental proposal in the matter, recommends the inclusion in the forthcoming budget estimates of an amount which is necessary for the support of the electricity works, which are in a state of financial distress. The money is to be granted either by way of a contribution towards the working expenses or in the form of a guarantee in some other manner, the conditions of which are to be subject to Royal Assent. On the other hand, and in the present financial situation of Norway, it is found impossible for the State to make any contribution towards the writing down of the capital expenditure incurred by the electricity works concerned.

---

**Glasgow Labour and Home Industries.**

In our last issue we announced that Glasgow Corporation was recommended to place an order for electric tramway trackwork with a foreign tenderer because the quoted price was lower than the offers submitted by British firms. There had been a previous proposition that the entire contract should be divided between the four tenderers—one American and three British. When the matter came before the Corporation at its meeting last week these recommendations were thrown to the winds, and in the end the contract was placed with the lowest of the three British tenderers, Messrs. Hadfields, Ltd. It is interesting to note that this amending policy "received support from all sections of the Corporation," but it is still more interesting, and may we say significant, to note in the Press that the successful amendment emanated from the Labour Party! The change-over in the Council took place, it is said, owing to the plea that in view of the depression, "British work should be kept for British people." Does it matter what it is called or who is responsible for it, so long as that end is striven for while our kith and kin at Home are unemployed? We prefer to refrain from hurried conclusions regarding the relation of the recent voting to the industrial thinking of the "working" sections of the electorate. Sir Chas. Macara has expressed in his recent book on the "New Industrial Era" the opinion that in future less attention will have to be given to party politics and more to practical affairs if we are to maintain our standing as the leading industrial and commercial nation of the world. The Glasgow Corporation was up against very practical affairs in connection with the above contract, and it has acted in a quite practical way. France, too, is just now up against very practical affairs when she observes us struggling with unemployment which is not without its bearing on the problem of international estrangement. She therefore makes offers of employment across the Channel for idle British workmen, and the British and French Ministers of Labour are reported to have come to an arrangement to that end, while French manufacturers are being invited to lend their co-operation. All of which reminds us that to give employment to the living might form reasonable recognition of the action of hundreds of thousands of "Contemptibles" and others who found occupation on the soil of France in 1914 and afterwards, and were never able to return.

---

**The Lighting of Factories.**

Although the meeting of the Illuminating Engineering Society on December 11th was nominally devoted to the application of illuminating engineering in practice, a great deal of the introductory paper and the ensuing discussion was concerned with industrial lighting. The authors (Mr. G. Herbert and Mr. R. A. Ives) laid great stress on the need for scientific data showing the relation between lighting and accidents, or the influence of good illumination in removing causes of interference with output. Some of the inquiries originated by the Society should yield useful information of this kind. Another point that was touched upon was the justification of the high values of illumination that are now being recommended to consumers. Curiously, the same point came up in the informal discussion on "The Lighting of Factories" at the Institution of Civil Engineers on the following evening. Mr. L. Gaster, who was present at both gatherings, did a useful service by explaining the distinction between values regarded as desirable in practice and "legal minima," which can naturally only be evolved with great circumspection. There is, we imagine, very little doubt that a vast number of factories throughout the country are underlighted. As Mr. Herbert and Mr. Ives pointed out, if all factories conformed merely to the *minima* indicated as desirable by the Home Office Committee, there would not be enough material in the country to meet the demand for lamps and reflectors. Hence such values, having the hall-mark of authority, are of great importance to the lighting industry even if naturally fixed on a somewhat conservative basis.

---

**The Cause of London Fogs.**

New light is thrown on the method of formation of London fogs by Dr. J. S. Owens in a letter to *Nature* of December 15th. Observations made with his automatic recorder during the series of fogs which visited the long-suffering Metropolis towards the end of November last showed that there was a rapid increase in density coinciding with the period of lighting fires in the morning, the maximum being attained about midday. It has generally been held that the fog consists of condensed water particles dirtied by smoke and oily hydrocarbons, and in fact there is usually a dense water fog in the surrounding country when London is thus obscured, but Dr. Owens has been driven to the conclusion that the London fog consists almost entirely of smoke particles alone. His records show little evidence of the presence of water amongst the immense numbers of small smoke particles; moreover, the range of visibility in the yellow fog is often actually greater than in the white fog outside London. The air over London, it is estimated, is about 13 deg. F. warmer than in the surrounding country, owing to the combustion of some 17 million tons of coal per annum, and therefore water fogs should be less dense and less frequent in the town than in the country. Hence, the London fog appears to be due to smoke, and if that can be abolished, London will be even less liable to fog than its surroundings.

The moral is obvious: we must heat our houses and cook our meals with electricity, gas, or smokeless fuel—anything but coal; and use electricity exclusively for power and traction—then we shall be rid of that costly, loathsome visitor known as the "London Particular."

# THE PRINCIPLES OF QUANTA SIMPLY EXPLAINED.

By R. W. WESTERN.

(*Concluded from page* 884.)

The principle of quanta applies as much to the vibration in which light manifests itself as to the revolution of an electron about the nucleus, and the amount of *action* concerned in the vibration may also be $h$ or some exact multiple thereof, as before. But because we have here to do with a motion of oscillation instead of one of rotation, the average of the vibration or wave of light will be exactly equal to its *action* divided by the time it occupies, instead of double, as in the case of the electron. The time occupied by a vibration is the reciprocal of the number of vibrations per second, because that is equivalent to the number of seconds per vibration, and the number of vibrations per second of a light wave is usually denoted by the Greek letter $\nu$. So dividing $\frac{3}{4}$ E, the energy lost by the electron in reaching the smallest circle from the circle next to it by $\nu$, we have—

$$\frac{\frac{3}{4}\,\mathrm{E}}{\nu} = h, \text{ or } \tfrac{3}{4}\,\mathrm{E} = h\,\nu.$$

The principle that *action* could be atomic, being contrary to the classical teaching of mechanics, was not established without difficulty, and it only came to be accepted, at last, by reason of the many physical phenomena for which it afforded satisfactory explanation. A single example will serve as an illustration, and we will describe one which carried great weight. Taking the circles which are possible orbits for an electron in order, beginning with the one nearest to the nucleus, we have seen that the energy lost in transition from the second to the first is $\frac{3}{4}$ E, which is—

$$\tfrac{3}{2}\,\frac{\pi^2 e^4 m}{h^2},$$

and by the same process of reasoning it may be shown that the energy lost in transition from the $k$th to the $n$th circle will be—

$$2\,\frac{\pi^2 e^4 m}{h^2}\left(\frac{1}{n^2} - \frac{1}{k^2}\right) = h\,\nu;$$

that is to say, a constant quantity multiplied by the difference between the inverse of two squared numbers. In the example we took, the numbers were 1 and 2, so the difference of their inverse squares was 3/4. Now, comparison of the frequencies of the light-waves corresponding to the many lines in the spectrum of an element, discloses the fact that each of them may be expressed as proportional to the differences between a number of fixed terms, and that these terms are all to be obtained from the reciprocals of squared numbers. Moreover, in the case of hydrogen, the atom of which is constituted exactly like the one we have been considering—consisting as it does of a single electron revolving about a nucleus having the same charge—the empirical formula for the frequencies of the many lines its spectrum contains is—

$$\mathrm{R}\left(\frac{1}{n^2} - \frac{1}{k^2}\right) = \nu,$$

where R is Rydberg's constant; and giving to $m$ $e$ and $h$ respectively the several values computed for them by physical researches, namely:—

$m = .9 \times 10^{-27}$ grammes.

$e = 4.77 \times 10^{-10}$ C.G.S. electrostatic units.

$h = 6.55 \times 10^{-27}$ C.G.S. units,

we obtain $\mathrm{R} = 3.29 \times 10^{15}$ per second, or dividing by $3 \times 10^{10}$, the velocity of light, R = 109,700 per centimetre of wave length.

The principle of action is as much concerned with the absorption as with the emission of light. So far we have dealt only with radiation which occurs in transitions of electrons from an outer to an inner orbit. There must obviously be transition of the contrary kind, whereby electrons regain the larger orbit. This takes place whenever the energy of the electrons is augmented, as occurs during absorption of light—visible or invisible; and if the increase of energy suffice, the electron may pass out of the sphere of attraction of the nucleus entirely, and so cease to be part of the atom; it is endowed with the balance of the energy $h\,\nu$ absorbed. It might be supposed that the atom was whipped up to higher speeds by the light falling upon it, as a whipping-top is by a boy to make it spin faster; but far from this being the case, the contrary is true; as we have seen, $v$ the velocity of the electron varies inversely with $r$ the radius of its orbit; and when by some mysterious process the electron is made to take an outer orbit, as the result of radiation absorbed, the rate of spin is decreased. Energy gained by the electron from absorption of light within the atom is, in fact, potential energy; just as is the energy it has been computed to lose by radiation. Thus energy is seen to be stocked in definite shapes and sizes, if we may so liken the quanta of *action* in which it is preserved and transmitted. Of course we can never examine it during the process of transmission, because when our instruments respond, the process is already over as far as they are concerned; all we can say is that, having ceased to exist at the source of light, the same energy, after an interval of time, becomes available at the place where the light falls; but why departure and arrival should be in units of any kind is difficult to understand.

The principle involved is new and unexampled; there are no ready means of illustration by which its working can be recognised in forms familiar; any model, to serve that purpose, will of necessity be very artificial; and the following construction is offered, only because a better is not at hand. Imagine a manufacturing system in which blanket-rugs are produced automatically at the rate of one per hour for each machine running, and that it is organised in factory-units operated by shifts of machine-tenders who are bound by an inexorable rule that the number of hours worked in a shift, multiplied by the number of machines tended by each man in it, must never exceed or fall short of 24. Imagine, also, that the men and the machines are alike unlimited in number, and that neither the workers nor their masters are actuated by any base motives of gain; so that the ideals of socialism are fully realised, in that the men only desire to seize every opportunity for working, while the masters think only of keeping the factories going. We may then postulate four possible ways of operating a factory unit, as set out in the following table:—

| 1 No. of men in a shift. | 2 Hours worked. | 3 Machines per man. | 4 No. of blankets made per shift. | 5 Output per hour. | 6 Possible additional output per hour. |
|---|---|---|---|---|---|
| (*a*) 6 | 12 | 2 | 6 × 24 | 12 | 24 |
| (*b*) 5 | 8 | 3 | 5 × 24 | 15 | 15 |
| (*c*) 4 | 6 | 4 | 4 × 24 | 16 | 8 |
| (*d*) 3 | 4 | 6 | 3 × 24 | 18 | 0 |

We can now offer the following similitudes:—

A factory-unit, consisting of a group of machines operated by shifts, in any of the ways (*a*), (*b*), (*c*), (*d*), as set out, may stand for the atom we have been considering. Any shift may stand for one revolution of the electron (*a*) in the outermost orbit, down to (*d*) for the innermost. Also, the labour contributed by each man in any shift, reckoned by the time it takes (col. 2) and the trouble he is put to (col. 3) may stand for the quantum of *action*. It will be seen that we do not, for the sake of verisimilitude, present a shift of less than

three men (col. 1). Then the action of each shift will be the product of: the number of men, the hours worked by each, and the number of machines he tends (col. 4); and this quantity must always be a multiple of the quantum each man contributes. The energy of a shift in either of the methods of operation will be its *action* divided by the period of the shift (col. 2); and the result, given in col. 5, is the same as the number of blankets produced by the shift in an hour. This energy is increased as we pass down the column, and illustrates the increased kinetic energy of an electron when it revolves in the smaller orbits. The sixth column, headed "possible additional output per hour," shows the extra number of blankets that might be produced in each hour, if every man tended as many machines as possible, that is to say, six machines, as in the (*d*) method of operation; and these figures represent the potential energy of the shifts. Note that the amounts obtained by adding the figures of cols. 5 and 6 decline as we descend by shifts from (*a*) towards (*d*), and so illustrate the reduced total energy of the electron as it drops to inner orbits.

Of course, no analogy can be pushed indefinitely, and the scope of this one is very limited. Nevertheless, it permits us to picture the men working on (*d*) shifts wherever they can, and being content with (*c*), (*b*) and finally (*a*) shifts when nothing better is at hand owing to blankets being too plentiful. We may also suppose supernumerary workers at any stage to take themselves off in confident expectation that the plethora of blankets in the place where they happen to be, argues a paucity elsewhere. It may be objected that what stands for potential energy is not really possible for the shifts to which it is imputed, and that it is an infringement of the inexorable rule laid down; but a like objection might also be made regarding the potential energy ascribed to the electron in its larger orbits—that it is not energy possible to that electron, since no electron can attain so much energy in the kinetic form, by approach to the centre. So the analogy does not break down here; on the contrary, it serves very well to illustrate the fact that, in the computation of potential energy, some element of convention may enter. What the whole potential energy of a body may be, there is no means of telling; in the foregoing calculation, to compute the amounts by which the energy was drawn upon was sufficient; and though it may be true, generally, that the total energy is constant, to state what the quantity is that undergoes no change is out of the question; the total energy of a $\beta$ particle embraces its mass.

The foregoing is intended to convey a general idea of the way in which the principle of quanta is applied to the explanation of fact. The following contains some speculation as to the implications of the principle. Potential energy, if it be not kinetic energy in disguise, as with the latent heat of steam, is energy that might be kinetic; the statement that the total energy of a system—kinetic and potential together—is constant, depends on a consistent use of the word might. Now, considerations derived from the electronic theory of matter, and supported by the theory of relativity, indicate that the energy of a body, both external and internal, is measured by its mass.

As was shown at the close of the articles explaining the principle of relativity in the Electrical Review, October 3rd, 1919, the kinetic energy acquired by any body is accounted for by the increase of its transverse mass. It was there shown that—

$$\text{E} = m_o c^2 \left( \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} - 1 \right)$$

in which E is the kinetic energy of a body of mass $m_o$, moving with the velocity $v$ with respect to the observer and $c$ is the velocity of light. The equation indicates that the mass of the body, which is $m_o$ when it is at rest, is increased to—

$$\frac{m_o}{\sqrt{1 - \frac{v^2}{c^2}}}$$

when it is moving with velocity $v$. According to the general theory of Einstein, the equation is—

$$\tfrac{1}{4}\, m_o c^2 \left( \frac{1}{\beta} \log \frac{1+\beta}{1-\beta} - 2 \right) \text{ where } \beta = v/c.$$

The inference to be drawn from this is that every body is made up of parts that move with $c$, the velocity of light; but, since a greater velocity than this is impossible, the super-added velocity $v$ will make no difference to the velocity of the parts of that body in the direction of the path in which it moves as a whole (besides, against any increase of mass due to a super-added velocity in this direction is to be set a decrease of mass due to diminution of the motion of its parts in the contrary sense); in respect, however, of the velocity of the parts in directions transverse to the path in which it moves as a whole, the velocity super-added will bring about an increase of mass as provided by the formula—

$$m_v = \frac{m_o}{\sqrt{1 - \frac{v^2}{c^2}}}$$

where $m_o$ is the mass at rest and $m_v$ the mass in motion. Of course, $v$ must be very large indeed to appreciably affect the mass of a body (once round the world in a second would not suffice to add one per cent.); nevertheless, in the case of the electron, such alterations in mass have been shown to explain some of the minor details of lines in the spectrum. It would thus appear that whatever has mass must have parts, and these parts must move with the velocity of light; moreover, the parts must be of a nature such, that at any less velocity they have no mass, because the theory requires that any mass whatever becomes infinite when moving with that velocity. Hence we can only conceive the parts to be points which may be centres, for the appearance of such forces as attractions and repulsions, but not for the force of inertia, unless they move with the velocity of light. It is possible the presence of such points may fulfil the purpose of an ether as a means for explaining phenomena like those of interference fringes, which seem to contradict the principle of quanta, and supply a mechanism for the photo-electric effect. Indeed, the impact of a $\beta$ particle emits an X-ray, and the impact of X-rays emits a $\beta$ particle; the initial and final energy being so nearly the same as to have suggested that matter and energy are mutually convertible.

Thus it is credible that the mass of a body may be due to its total energy, both external and internal, if all the potential energy reckoned in is really kinetic energy in disguise; but there seems no reason for thinking that its mass can be affected by energy that is purely potential. It is possible, for example, that steam may, by virtue of its latent heat, weigh more than the water of condensation at the same temperature (though the difference would be far too small to detect by any means at present available); but there seems no reason to think HCl should weigh more than its constituent gases. Hence it cannot be said that the doctrines of the conservation of mass and the conservation of matter are one and the same, as many have surmised; it is more reasonable to suppose that, in mass, we have an ultimate criterion by which to discriminate between potential energy and hidden kinetic energy.

We learn from the quantum theory that *action* is parcelled out. We learn also that energy is parcelled out; these quantities have two dimensions in common, *i.e.*, space and force, so the parcelling-out must arise from discontinuity in one of these. Now it is as difficult to believe that space is discontinuous as to believe that time is, because however small the interval of either, to think it cannot be divided is impossible. Only force remains to be manifested in parcels of fixed magnitude and thus determine the quantisation of *action* and energy, and possibly also of momentum. According to this reasoning, when an atom emits light, acting forces and forces of inertia hitherto exhibited in one orbit may disappear after completing a fixed quantity of *action*; and like forces then enter into activity in another orbit, or elsewhere, to repeat quanta of *action* of like magni-

tude. There is nothing in mass that cannot be presented as force, but it is easier to think of this magical change in terms of force, rather than mass. It is then difficult to see why quantisation should be confined to forces concerned with periodic motion such as radiation. Perhaps force is quantised in all its manifestations. In that case a difference between static and dynamic forces, which has always been a stumbling block to students of mechanics, may be resolved. The difficulty is this:—

When two bodies act upon each other, as in the process of impact, the acting force in every case is equal to the reversed effective force; in other words, the forces of inertia balance the other forces; indeed the distinction between them is quite artificial, seeing that it depends upon the position chosen for the frame of reference. Upon the dynamic equality of these opposing forces, change in the relative velocity of the two bodies we consider ensues. On the other hand, equality of opposing forces that are static gives rise to no change of relative velocity. Indeed static forces and dynamic forces differ in kind, when the first may be considered to exist independent of any motion, while the second can only be considered to exist while motion is in progress, and the difficulty is not removed by the fact that forces like that of gravitation may be either the one or the other.

Comparison between them, however, becomes easy if the *action* of each body upon the other is supposed to take place by quanta of fixed amounts. Let the fixed amount be $pst$ in units of force, space, and time; then, if $p$ be a force of inertia, its duration is inversely proportional to $s$; while, if it be a static force, it endures for ever, $t$ being infinite when $s$ is nothing.

Considering, then, the interaction of two molecules colliding with impact direct, each elementary constituent of either body gives rise to quanta of *action*, equal in amount but different in constitution. Using large letters to denote large factors and small letters to denote small factors, the small body will harbour quanta of long extension but short duration, $pst$ in the line of action; and the large body will harbour quanta short in extension but long in duration, $pST$; $p$, the indivisible element of force, presenting itself, in each elementary constituent, in numbers at a rate which is proportional to their accelerations. Thus, if $n$ and $N$ be the number of elementary constituents in each body, the *actions* of the bodies will be as $nFpst$ and $NfpsT$ respectively. Also their action per unit of length, for the distances traversed while they are in contact, will be measured by $nFpt$ or $NfpT$; because these two quantities, measuring as they do the change of motion in either body, must be equal. Hence, $nv = Nv$, where $v$ and $v$ measure the numbers of indivisible elements of force presenting themselves in each elementary constituent of the small and the large body respectively during contemporaneous units of time, showing that the frequency with which the atom of force appears, compensates for the numbers in which it makes its appearances. This implies quantisation of momenta.

These considerations suggest that the principle of quanta may arise from atomicity of force.

# THE ELECTRIFICATION OF THE MEXICAN RAILWAY.

## The First Section, from Esperanza to Orizaba.

(By a Special Correspondent.)

The relatively small amount of railway electrification that has taken place in Mexico is sufficiently accounted for by the disturbed political conditions in that country, which have lasted, with but slight interruptions, since 1911. But for this fact a further considerable amount of British capital would have been invested in electrification schemes; but, even as things are, something has been done towards the completion of at least one electrified system.

After mature consideration, rendered necessary from both a political and a financial point of view, the Mexican Railway Company has commenced work upon what, it is hoped, will eventually prove to be the complete electrification of its system, confined, however, for the present to the most difficult part of the line, namely, that between Orizaba and Esperanza, where the track rises over 4,000 ft. in a distance of some 29 miles, with a ruling gradient of 1 in 24.

Among many other favourable engineering features present has been the fact that the system, as a whole, is found to be particularly well situated for electrification, power transmission lines paralleling the railway for a great portion of its length at such a short distance as to call for practically no additional expense to deliver the necessary current to the sub-stations; while a brief examination of the operating costs of the entire system shows that a very considerable economy can be secured by substituting electric for steam traction.

It was found that the capacity of the line when electrified would be more than doubled, and the proposed substation and distributing system of the line would be easily capable of handling regularly double the maximum day's traffic which is now being operated by steam.

The Mexican railway was originally laid between 1870 and 1875, and constituted the first railway of any importance to be built in the Republic of Mexico. It remains to-day the principal route from the coast to the capital, the only competing line from Vera Cruz being the Interoceanic, which, however, is a narrow-gauge line and is heavily handicapped by having to follow a much longer route.

From Mexico to Esperanza the Mexican Railway line follows the general contour of the plateau, resulting in frequent reversal of gradients, but none of these exceeds 1.5 per cent. The elevation at the terminus in Mexico City is 2,233 metres (7,323 ft.). The highest point on the line is near Acocotla, 152 km. (95 miles) from Mexico; the elevation is 2,526 metres (8,288 ft.), a rise of 292 metres. From this point to Esperanza—a distance of 93 km. (58 miles)—the drop is 73 metres and the surface undulating as before.

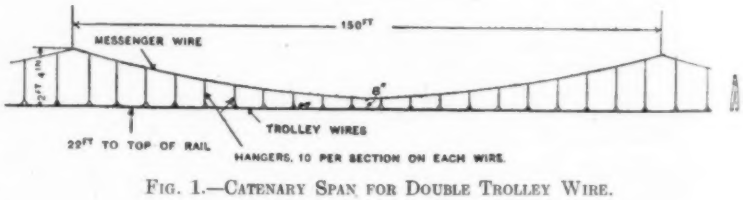


Fig. 1.—Catenary Span for Double Trolley Wire.

At Boca Del Monte—6.1 km. (3.8 miles) west of Esperanza—the plateau ends suddenly, and the descent for the following 30 km. (18.5 miles) to Encinar is very rapid. In this distance there is a drop of 1,070 metres, making the actual average non-compensated gradient 3.53 per cent. In addition to this unusually steep grade, for approximately 27 km. (17 miles) of the distance the line follows the corrugated contour of steep mountain slopes, making a zig-zag course which results in a continuous series of reverse curves. The scenery looking down the Maltrata Valley and the Infiernillo Gorge is most beautiful.

At Encinar the grade becomes normal, and the line

enters the Valley of the Rio Blanco. Orizaba—47.4 km. (29.4 miles) from Esperanza—is the division point, and the place where the repair-shops and offices of the second division of the railway are located.

From Orizaba to Paso Del Macho the drop is considerable, though much less rapid than that just described. In the 55.8 kilometres (34.5 miles) there is a descent of 752 metres (2,466 ft.). There are many comparatively long sections of tangent track, and the curves, except in the loop along the Metlac, are not unusually numerous or seriously sharp.

The section from Paso Del Macho to Vera Cruz is a gradual descent from elevation 475.6 metres (1,560 ft.) to sea-level; the ruling gradient is approximately 1.7 per cent. and the alignment normal. There are no unusual physical conditions except that in the immediate vicinity of Vera Cruz the salt air is very active in deteriorating ordinary metals; phosphor bronze will accordingly be used where practicable in connection with the exposed portions of the electrical distribution system.

The direct-current system with 3,000 volts trolley pressure is to be used for the electrification of the Mexican railway. The system proposed is of the same general design as was installed on the Butte, Anaconda and Pacific Railway in 1913, and on the Chicago, Milwaukee and St. Paul Railway in 1915, both of which have given satisfactory results. The type of catenary suspension to be employed is shown in figs. 1 and 2.

The district now being electrified (Orizaba-Esperanza) comprises 47.4 km. (29.5 miles), and is undoubtedly the most difficult and expensive district to work with steam locomotive power. The steepest grades are between Encinar and Boca del Monte. Except for the first 4 km. out of Encinar to Balastrera, there is practically no tangent track on this heavy grade, and many of the curves have a radius of only 107 metres (351 ft.). The average grade, after liberal compensation for curvature, is approximately 4.1 per cent.

The profile of the line shows the maximum non-compensated grade to be 4.1 per cent., but recent checks have indicated that there are short sections 300 to 500 ft. in length where the actual grade is as much as 4.4 per cent., and when compensated for the maximum curvature at the rate of .05 per cent. per degree of 100-foot chord, it is equivalent to a grade of 5.24 per cent.

For electrical operation a locomotive unit is proposed consisting of three articulated trucks, on which will be mounted six traction motors, the complete unit weighing 300,000 lb., all on drivers, and capable of exerting at the wheel-rims a tractive effort of approximately 50,000 lb., at 6, 12 or 18 miles per hour with full 3,000 volts at the locomotive. This is the normal one-hour rating.

Arrangements for shunting the fields will be provided, securing additional speeds with lighter trains or on easier grades when desired. These units will be capable of either independent or multiple-unit operation, so that two or more units may be combined into a single locomotive and operated by a single crew, as is now done with the double-ended steam locomotives.

This locomotive unit should be capable of hauling a 300-ton trailing load up the heavy grade, Encinar to Boca del Monte, at 6, 12 or 18 miles per hour, and two such units should handle 600 metric tons, or three units, 900 tons trailing load. The most economical operation would, perhaps, be to combine two such units into a single locomotive to be placed at the head of the train, and operated by a single engine crew with 600 tons trailing. However, it is usually considered a safer practice to have a helper-locomotive at the rear end of freight trains on such steep grades.

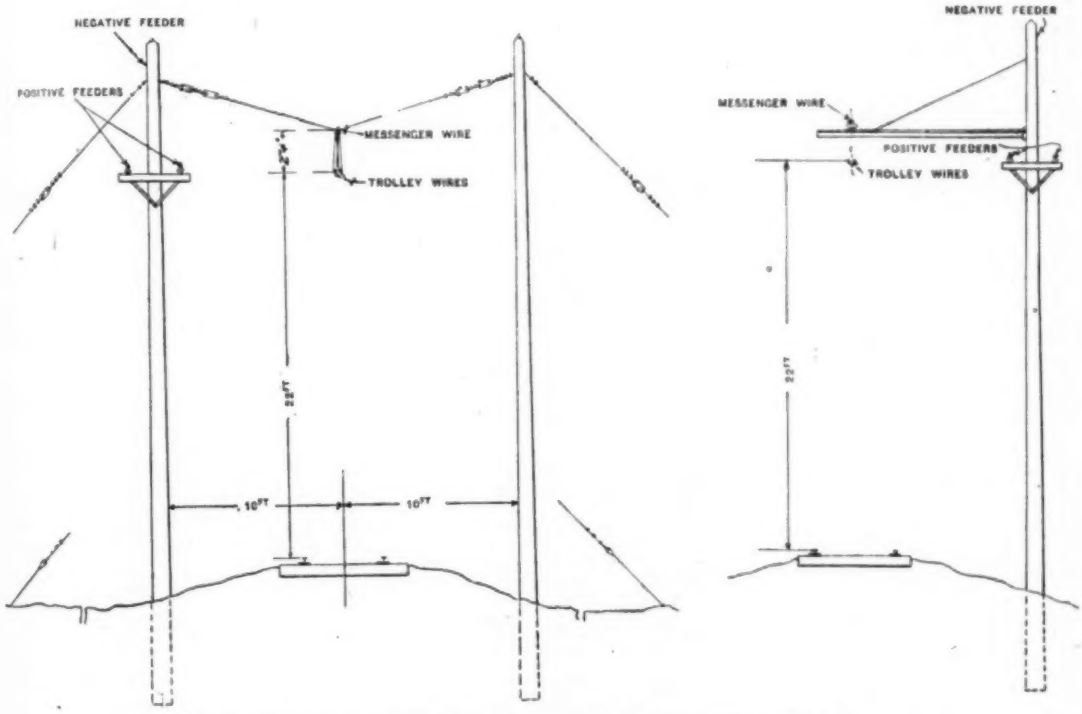


Fig. 2.—Cross-span and Bracket Construction for Double-Trolley Line.

In the following estimates it is assumed that the same rate of wages will be paid enginemen for operating a single-unit electric locomotive as they now receive on the steam locomotives, but that 10 per cent. extra will be paid for the operation of a double unit. In the case of trainmen, it has been assumed that on account of the braking being done by the regenerative features provided on the electric locomotive, which eliminates practically all hand-braking and greatly increases the safety of operation, the train crew will consist of a conductor and two brakemen, as is customary in the United States, and that they will receive standard wages when operating a 600-ton train with a unit at each end, but will be allowed a 10 per cent. increase if the two locomotive units are combined at the head-end of the train, or if more than two locomotive units are used per train.

The comparative estimated annual costs for the freight service of the items affected by electrification for four suggested methods of electrical operation, Orizaba to Esperanza, per year, U.S. currency, including 10 per cent. for overtime and miscellaneous train service, are as follows:—

| | | | | |
|---|---|---|---|---|
| Rated tons trailing ... | 600 | 600 | 900 | 1,200 |
| Loco. units per train ... | 2 | 2 | 3 | 4 |
| Engine crews per train | 1 | 2 | 2 | 2 |
| Enginemen's wages ... | $21,785 | $39,611 | $27,728 | $21,808 |
| Trainmen's wages ... | 26,441 | 24,307 | 17,825 | 13,382 |
| Energy purchased ... | 134,000 | 134,000 | 150,000 | 200,000 |
| Loco. repairs ... ... | 47,250 | 47,250 | 47,250 | 47,292 |
| Engine-house ... ... | 5,400 | 5,400 | 5,400 | 5,405 |
| Lubricants ... ... | 2,700 | 2,700 | 2,700 | 2,700 |
| Total per year ... | $237,576 | $253,268 | $250,903 | $290,587 |

The energy estimate is based on the assumption that it can be purchased, delivered at the sub-station, at $25.00 per year per horse-power, maximum five-minute demand. In the case of the 900- and 1,200-ton trains, it has been assumed that the trains would all be moved up the grade between 11.30 at night and 5.30 afternoon, or during 18 hours, and that no heavy movements would be made from 5.30 to 11.30 p.m., thus avoiding the necessity of greatly increasing the installed capacity of the power companies' plant, and that the cost of energy would be regulated accordingly. These power costs will become matters for mutual adjustment between the railway and power companies, and the prices quoted above are merely given as a basis for estimating.

The energy returned to the line by regenerative braking would aggregate many hundred horse-power-hours per year, but could not be relied on greatly to decrease the maximum demand on so short an electrified

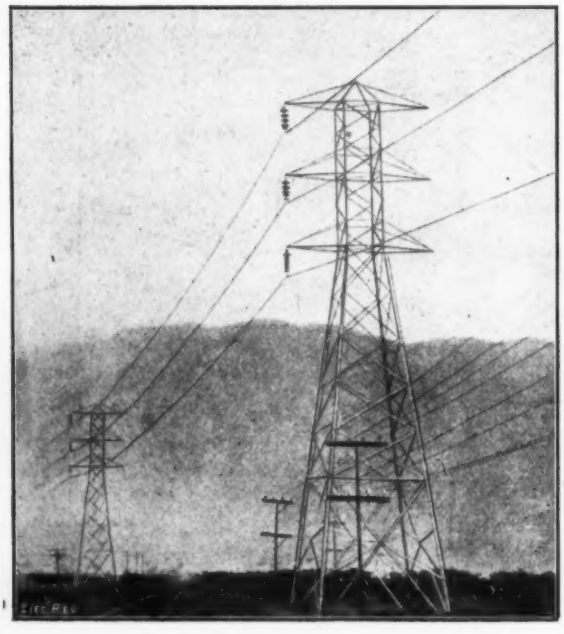

Fig. 3.—130-km. 100,000-V Transmission Line Crossing Railway near Santa Rosa.

section where the tonnage coming down the grade is hardly one-half that to be taken up.

Assuming that with electrical operation the yearly tonnage would be at the rate indicated by the average for the months of September and October (1921), the total tons per year from Orizaba to Esperanza northbound would be 175,625 × 6 = 1,053,756 metric tons.

On the basis of an average trailing load of 540 or 810 metric tons, which allows for a 10 per cent. reduction below the standard train rating, the average number of freight trains northbound per year would be 1,951 or 1,301, as against 3,162 with steam operation, a reduction of 1,211, 38 per cent., or 1,861, 59 per cent., respectively, depending on the adoption of the two or the three locomotive units per train.

The electric locomotive unit proposed should make the trip, Orizaba to Esperanza, with 300 tons trailing without stops in one hour 45 minutes; 2 hours 15 minutes; or 4 hours 15 minutes, depending upon the speed combination used, that is, 18, 12 or 6 m.p.h. To this net running time should be added approximately 20 minutes margin for possible delays, making the average road times 2 hours 5 minutes, 2 hours 50 minutes, and 4 hours 35 minutes respectively.

On account of the lighter grades, Orizaba to Encinar and Boca del Monte to Esperanza, which average less than 1.5 per cent., a second train could be started from Orizaba on the arrival of its predecessor at Boca del Monte without exceeding the maximum power demand required by the single train on the heavy grade, thus making it possible to dispatch trains at intervals of 1 hour 50 minutes, 2 hours 30 minutes, or 4 hours, or, at the rate of 13, 9, or 6 trains per 24 hours as a possible maximum with the least maximum power demand.

Ten trains per day at the higher speed should regularly be handled over this section without exceeding the maximum demand of power required for the one train on the heavy grade. This higher speed (18 m.p.h.) would be practicable for the passenger-trains, but would not be advisable for the freight-trains on the portion of the line where there are sharp curves; as a considerable portion of the line on the heavy grade has this handicap, it would seem advisable to select the 12-m.p.h.

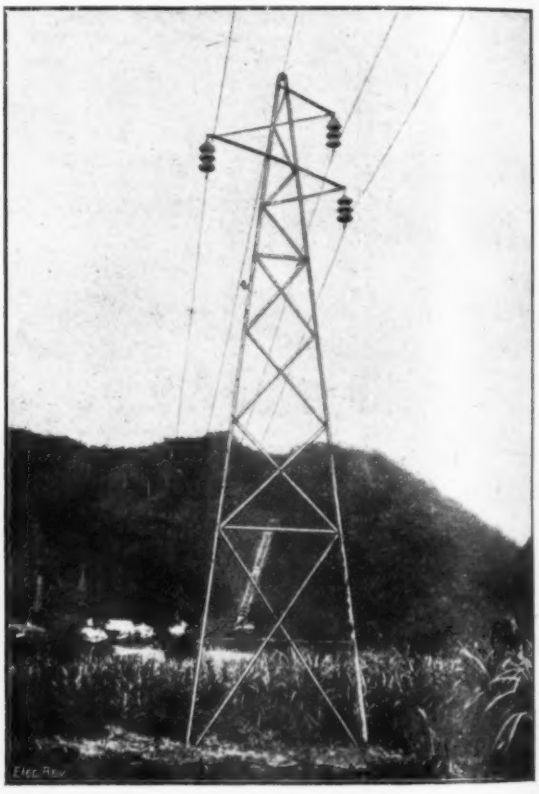

Fig. 4.—40,000-V Transmission Line from Power Station to Vera Cruz.

speed combination for freight-trains between Encinar and Boca del Monte, and to use the higher combination from Orizaba to Encinar and Boca del Monte to Esperanza when desirable.

The lowest speed combination (6 m.p.h.) would be used only when it was desired to limit the speed or the power demand. With the 12-m.p.h. speed on the heavy grade, and the higher speed elsewhere as suggested above, it should be possible to send 10 trains from Orizaba to Esperanza each 24 hours. Allowing that two of these trains will be passenger, there remain eight for freight service. This would make the maximum capacity on this basis—

8 × 600 = 4,800 tons per day.
8 × 900 = 7,200 tons per day.

For regular operation it would be easy to average—

7 × 600 = 4,200 tons per day.
7 × 900 = 6,300 tons per day.

The maximum tonnage hauled north on any day during September and October (1921) was 4,648 tons taken up on 14 trains, two of which were passenger trains aggregating 639 tons metric, which leaves as freight

4,009 tons. It is, therefore, evident that the average electric service with the 600-ton train would readily meet present maximum demands with a small margin, and that with the 900-ton train there would be a margin of 50 per cent. excess capacity. The average daily traffic for the period mentioned was 3,233 tons, of which 2,879 tons was freight.

Thus for the average traffic of 2,879 tons, 5 freight-trains of 600 tons each, or 4 trains of 900 tons each, would be sufficient, making the average trains per day, including two passenger trains, 7 or 6 accordingly.

However, in order to provide for a probable increase in business, the company will find it advisable that sufficient equipment and power be arranged for in the initial installation to handle regularly 4,000 tons per day, and a maximum of 6,000, in addition to the passenger trains, which will require, with 600 tons trailing, 7 trains per day regular service and 10 maximum, or, with 900-ton trains, 5 regular and 7 maximum. Including two passenger-trains this would be a total of 9 trains regularly and 12 maximum, or 7 trains regularly and 9 maximum, depending on the train unit selected. It is evident that the 900-ton train has the advantage in capacity, and it has already been shown that in general it is more economical than the 600-ton train with two engine crews.

Since the ruling grade is equivalent to 4.7 per cent., and on the basis of 6 lb. per ton rolling friction, the pull per ton would be 110 lb., making the draw-bar pull of the locomotive for the 600-ton train 66,000 lb. Based on a coefficient of adhesion of 16 per cent., the locomotive for this service should have a weight on drivers of approximately 273 tons metric for the 600-ton train, or 410 tons for the 900-ton train, making the gross train weights 873 tons or 1,300 tons. The tractive effort required of the locomotive units would be 96,000 lb. or 144,000 lb. respectively.

The power required for these trains on the ruling grade would be:—

*For the 873 gross ton train:*

| | | | |
|---|---|---|---|
| At wheel rims ... | (96,000 lb.) | | = 2,304 kW |
| ,, locomotive ... | 2,304 ÷ | .85 | = 2,710 ,, |
| ,, sub. d.c. ... | 2,710 ÷ | .90 | = 3,010 ,, |
| ,, sub. h.p. ... | 3,010 ÷ | .85 | = 3,541 ,, |

*For the 1,300 gross ton train:*

| | | | |
|---|---|---|---|
| At wheel rims ... | (144,000 lb.) | | = 3,456 kW |
| ,, locomotive ... | 3,456 ÷ | .85 | = 4,065 ,, |
| ,, sub-station d.c. | 4,065 ÷ | .90 | = 4,517 ,, |
| ,, sub-station h.p. | 4,517 ÷ | .85 | = 5,315 ,, |

In order to allow for light switching units, the maximum power demand should be placed at approximately—

4,000 kW for the 600-ton train,
6,000 kW for the 900-ton train.

The accompanying illustrations, figs. 3 and 4, show parts of the Puebla Tramway, Light and Power Co.'s overhead lines in the vicinity of the railway.

## INDUSTRIAL RESEARCH.

By E. KILBURN SCOTT, M.I.E.E.

In Section III of the paper which he read recently before the Institution of Electrical Engineers, Mr. W. Wilson refers to the large number of cases where pioneer work done in this country has been brought to fruition abroad, and he specially mentions fixation of atmospheric nitrogen. He does well to include this reference, because it typically shows the various stages and the very long period required to bring a discovery to commercial success.

In the case of synthetic nitrate, Priestley, Cavendish, and Rayleigh did the *academic* research, and the *technical* or *industrial* research was done much later by Macdougall and Howles (English), Bradley and Lovejoy (American), and Birkeland and Eyde (Norwegian). Finally, the process was commercialised, or industrialised, by Birkeland and Eyde; Pauling (an Austrian) and Schonherr and Hessberger (Germans).

In the case of synthesis of ammonia, the *academic* research was done by Haber (German) and Le Rossignol, a British subject working with Haber, whilst the *technical* or *industrial* research was done by an entirely different group, notably Bosch and Mittasch, of the Badische Anilin und Soda Fabrik, and metallurgists of Krupps', who made catalyst bombs to withstand hydrogen and ammonia gases at 600 deg. C. and 200 atmospheres pressure.

This synthesis was the most difficult chemical engineering problem that has yet been solved, and its solution has opened up great possibilities in other directions with catalysts and super-pressures. Already Claude (French) and Casale (Italian) have advanced to pressures much higher than that above mentioned.

In order to work out the details, the Badische Co. built a research laboratory measuring 300 ft. by 100 ft. by eight storeys high, and had over 200 experts working in it during the war; and even after the war, representatives of the Allies found 75 still there.

Before the United States came into the war, the Government voted 20 million dollars for technical researches to be made into four different ways of fixing nitrogen. Since then the Government has consistently aided this research, and at the present time there is a fixed nitrogen research laboratory at Washington, D.C., in charge of Dr. Cottrell, which has a staff of over 100 experts and an annual budget of £50,000.

The United States Government spent 110 millions of dollars on a plant at Muscle Shoals to produce 300 tons of ammonium nitrate per day, and at the time of the Armistice had three other plants under construction at Cincinnati, Toledo, and in Maryland, which would have cost nearly twice as much. I mention these figures to show how a country that is much nearer to Chilean supplies of natural nitrate than we are, faced the situation.

Apathy of the authorities in this country allowed our supplies of fixed nitrogen to get almost to the danger point. Many engineers and chemists in the U.S.A., France, Italy, and Japan were encouraged by their Governments to make researches and to build plants for the fixation of atmospheric nitrogen, whereas in this country very little was done.

The apparatus installed by the late Dr. Harker and Dr. Greenwood for nitrogen research at University College is said to have cost £10,000, and the total expenditure authorised by our Ministry of Munitions was not much more than double that figure. Therefore, we spent about one-thirtieth of what the U.S. Government voted for research *before* they even came into the war, and about 1/1,500th of what they eventually spent. Our expenditure was probably less than 1/15,000th of what was spent in other countries towards the fixation of atmospheric nitrogen and the construction of power stations for this purpose, including the 185,000-kW steam station built at Bitterfeld during the war.

The research plant at University College should have been kept intact and researches proceeded with, but instead of that all the apparatus was dismantled just as if it were machinery for merely making shells or fuses. There was unworthy intrigue behind this sabotage, and I hope it will be brought to light some day.

The question of nitrogen fixation is of great importance to the Empire, for it closely concerns the production of cheap food, and minimising of famines in such countries as India, where the production per cultivated acre is ridiculously low. It closely concerns the development of the hydro-electric and the fuel-power resources of the Empire. It is also a form of national or Empire insurance, for, in the event of a war in the Pacific, the position of any Dominion which cannot make its own nitric acid and ammonia nitrate will be precarious. If it is necessary to have a fleet in the Pacific and a dockyard in Singapore, then it is also necessary to make explosives in that part of the world.

Personally, I look forward to the day when every Dominion of the Empire will have at least one large plant for fixing atmospheric nitrogen, and I see enormous electrical engineering possibilities in harnessing water power for the purpose. That it will pay to do so I have no doubt, but in any case the policy has an insurance value, for it is on all fours with the policy that insists on the necessity of military and naval expenditure, dockyards and stores for keeping them efficient.

Mr. Wilson rightly points out that it is important for this country to *initiate* inventions and improvements because of the prestige it gives us abroad. What people talk about in their homes overseas is different to the cheap chatter of hotels, or the biased comments of newspapers. Our folk overseas look to us at home to be *initiators* and *creators* in engineering practice, as was the case in the last century, and not merely to lead in such businesses as soap boiling and tea blending and other trades of the "Mincing Lane" order. One cannot "throw much of a chest" about businesses which are based on the exploitation of cheap coloured labour however large the returns may bulk in statistics of trade.

The Deutsche Bank, which was largely responsible for the rapid development of engineering and chemical industries in Germany before the war, had its own department of scientific and technical research; in fact, the technical side of the bank ranked with the Charlottenburg Technical School. I mention this in order to show that scientific and industrial research is very much the business of financial concerns. If it is distasteful to some readers to be reminded of what the Germans did, I would say that in the United States the National City Bank and several insurance companies have been largely identified with electrical power and manufacturing developments in that country.

This brings me to a statement about the most useful research institution I have seen, *viz.*, that founded by some bankers of Pittsburg—the Brothers Mellon—one of whom is now political head of the Treasury of the U.S.A. As there may still be some who do not know about the Mellon Institute, it may be well to say that the scheme was developed by the late Prof. R. Kennedy Duncan at the University of Kansas as a result of the lack of contact between the University and industrial life. It was such a success that the Brothers Mellon built and endowed a building in Pittsburg, and gave Prof. R. K. Duncan the chance to develop his ideas.

It is called the Mellon Institute of Industrial Research and School of Specific Industries, and any manufacturers or individuals desiring its aid may endow a Fellowship for one or more years to cover the salary of the research worker and cost of materials. The Director and his staff give general supervision and assistance. I wish to emphasise the fact that the *researches are not done by any of the permanent staff*. Publication of results is deferred for a period of years, generally three, and there are provisions in the agreement by which the research worker benefits from any original inventions he may make.

The Institute is not for academic research such as is done in universities and national laboratories. The industrial aspect is strongly emphasised, and that it has filled a want is shown by the many hundreds of valuable technical researches that have been carried out there and by the great demand for Fellowships in the Institute.

I think this country wants an institution to fill the gap between the academic research of universities and such places as the National Physical Laboratory and industrial researches which are carried on in the *private* laboratories of firms such as the General Electric Co. and Metropolitan-Vickers Co.

I admire exceedingly what these firms have done, but I want to see those individuals catered for, who are outside of universities and cannot get into the big manufacturing concerns. I want an institution where *anyone* can go and carry out a piece of technical or industrial research—where he can have free use of testing apparatus and instruments of precision and be in an "atmosphere" which is conducive to *creative engineering* work. This, I feel, can best be done in an organisation such as Prof. Kennedy Duncan had "the vision to suggest and organise" and the Brothers Mellon had the enterprise and public spirit to finance.

I do not suggest that the details of organisation of this Institute need be slavishly followed, but I am convinced that the ideal service to miscellaneous investigators, inventors, &c., will be on similar lines. It gives opportunities to many who would not otherwise be catered for.

Just as industrial operations require carefully-planned buildings and special apparatus and tools, and the co-ordination of many factors—light, heat, power, electricity, &c.—so also does technical research require a suitable environment or atmosphere. In the Mellon Institute the work of a considerable number of very varied researches "sails along" with a minimum of friction and of time in assembling the apparatus, &c. The building has plenty of apparatus and the helpful co-operation of an efficient staff. Members of the staff do not carry out any researches themselves, but they help the holders of Industrial Fellowships to be efficient.

Anyone with an idea that requires working out and the necessary funds for an Industrial Fellowship has the matter "passed upon" by experts, and if the latter are satisfied that it is a piece of work that will ultimately be of general benefit to the community, then opportunities for carrying it out are provided *without stint*. The Institute is not a place of scrap apparatus or sealing wax and string, and the operations are not retarded by teaching.

I know from personal observation something about trying to carry on teaching and technical research in the same place, and my view is that they do not go well together. If one is done well, the other is done badly.

Our research organisations have high-sounding names and many committee men and some accomplished retarders or "stand patters." We have not anything approaching the Mellon Institute. For example, the British Electrical and Allied Industries Research Association is quite different. The researches of the latter are carried on in various parts of the country and are directed from London by committees largely made up of tired and worried business men. I also understand from Mr. Wedmore that it is the intention always to employ a certain small number of investigators who are to be switched on one piece of work after another.

This wholly fails to meet what I have in mind, and is likely to do badly what firms can do themselves, whilst giving no assistance to individuals or to small firms. There is no central building and no miscellaneous collection of apparatus to draw upon; also, as the researchers are not working on *their own personal* ideas, there is no *personal incentive*. Their reward is much like that of salaried civil servants, and they must necessarily work on atrophied civil servant lines.

Arkwright worked out the spinning mule because he was working on his own idea. Bramah developed hydraulic engineering because he made his own apparatus. The steam turbine became a success because Sir Charles Parsons was working out his own invention. The creative inventive work which I have in mind when I speak of industrial technical research cannot be deputed to others who are mere memorisers or "examination passers."

One of the most important features of the Mellon Institute is the constitution of the Industrial Fellowships. Owing to Prof. Kennedy Duncan's foresight, the rules are such as to protect the inventor, and after a certain period it also provides for the disclosure of the data of the research for the general benefit of the particular trade to which it belongs. I cannot find that any research organisation in this country has recognised the necessity of protecting the research inventor from unfair exploitation by those who, by inheritance or otherwise, own the counters of bargaining.

During the war, and after, certain things were done with the sanction of the Government of this country which almost savour of sharp practice, as anyone can see in a book called "The Nitrogen Industry," by Drs.

Partington and Parker. Such things retard progress and tend to cause inventors to leave creative work, for which they are specially suited, in order to take up routine work or other occupations, in which, at any rate, they will get full credit for what they do.

I believe this country has in an unusual degree much native genius, and in the past many great inventions were made by individuals who had had no special training, such as, for example, Arkwright, Bessemer, and Bramah, to go no further than the B.'s. We want a scheme which in this time of specialisation will discover the "village Hampdens" of creative engineering. I am not concerned about producing thousands of men with degrees, which have been partly gained by trick memorising of formulæ equations and data, but I would like to see something done which will help "to discover" the future Edisons, Swans, Crookes, Ferrantis, Parsons, &c.

# EXTRA-HIGH-PRESSURE TRANSMISSION LINES.

By R. BORLASE MATTHEWS, Wh.Ex., A.M.Inst.C.E., M.I.E.E., F.R.Ae.S.

(*Continued from page* 888.)

### Overhead Lines.

Mr. W. B. Woodhouse read a paper, prepared jointly with Mr. E. B. Wedmore, which gave an excellent summary of the recent work of the Electrical Research Association. This report dealt with the strength of wooden poles and of their foundations; the mechanical properties of wires; the wind pressures on wires and structures; and the physical properties of porcelain. As such a report is chiefly a statement of the results of tests, it does not call for much comment. A very interesting indication, however, was given to the effect that an electrical method of measuring the porosity of insulators is under consideration. This is a matter of considerable moment, as it is one of the important directions in which fully satisfactory tests are not yet available.

### Insulators.

The day for the manufacture of extra-high-pressure insulators from the natural clay—of however good a quality—has passed. Nowadays various additions are made to good clays, to obtain the desired results of high insulation, non-cracking, non-capillarity, non-ageing, &c. The usual composition is kaolin, plastic clay (of secondary geological occurrence, with more of the fluxing oxides and finer of grain than the kaolins), finely ground quartz, or some other form of non-plastic and refractory mineral matter, ground and cemented in a matrix of glass which is produced through the fusion of felspar or other fusible silicates. That the whole subject is really a very complex one was borne out by a paper written by Mr. F. H. Riddle. In America there has been a distinct development in two directions (*a*) to replace the quartz by various substances, *e.g.*, sillimanite; and (*b*) to substitute other fluxes for the felspar. Having found out a good material, the manufacturer's troubles are not ended, for serious difficulties in forming, drying and firing have still to be encountered.

The pin-type insulator is rapidly giving place to the chain-type. On the Continent, it is preferred by some engineers for even as low voltages as 10,000. In America, for any voltage over 60,000, chain insulators are now the standard. Of course, their use involves the employment of higher towers; and, in the case of a single three-phase line, a somewhat awkward design for the topmost supporting arm.

The point was brought out as to the importance of the provision for some slight flexibility or freedom in the cementing medium between the porcelain and the metal fittings. Only too many failures have occurred in the past due to cracks caused by varying expansions of the porcelain, cement and steel, composing the complete insulator.

One of the three best papers of the Paris Conference was that by Mr. C. E. Bennett (Barcelona) entitled "The Insulating Problem from the Operating Man's Viewpoint." Its outstanding feature was that it was the outcome of practical experience of the operation of 778 km. (say 440 miles) of 110 kV line in Spain. For nine years the generators and turbines on this system have run without stop—other than that pre-arranged for periodical overhaul. Three-fourths of their troubles have been due to insulators. Fifty-four days without a service interruption has been their longest period of immunity over the whole line, though a section of 74 km. (say 40 miles) has been uninterrupted for two years and eight months. The author very wisely points out the importance of economy. The insulation of a line must be as good as the service justifies, but it must not be better. If money were no object, reliability could be greatly improved by very heavy construction, the cost of which would be all out of proportion to the amount of power distributed. As the modern tendency everywhere is toward the interconnection and consolidation of transmission networks with unification of operating voltages where possible, suspension insulators are to be preferred, since the voltage of a line may be so easily increased if necessary by adding one or two more insulators. The author considers that the ordinary dry and wet flashover and puncture tests are excellent for assisting the operating engineer in eliminating insulator types which show a wide variation from the average; however, present-day tests seem to give no indication of the greatest trouble of all, which for lack of a better term is called "ageing." Mr. Bennett tests for "ageing" by an examination of the porcelain for crystal structure, porosity, surfaces of cleavage, and bonding between the clay and the glaze. The percentage of thus faulty insulators which most manufacturers allow to go through is much higher than it should be. The insulators which pass this inspection test are then placed in fuschine solution for several days for an absorption test, at a pressure of about 100 atmospheres (about 1,500 lb. per sq. in.). The expansion properties of the insulator components are next tested by alternate submersion in hot and cold water. The interesting fact came to light in the course of Mr. Bennett's paper that the depreciation of strain insulators averaged ten times as much as that of suspension insulators. It would almost seem that it is really the position of the insulators that matters, for a number of strings were stored on the ground in a horizontal position, for nearly three years, during the re-building of a line. Before re-erection, they were re-tested and were found to have depreciated 45 per cent., although they had not been subjected to either mechanical or electrical strains. Mr. Bennett recommends testing strain insulators at least twice a year. Among other notes, it was observed that the insulator nearest to the ground was most liable to depreciation—this is probably due to mechanical vibrations.

Mr. Bennett usually employs the Megger for testing insulators in the stores and the aislometer for testing those in service. Megger tests are never made in the early morning or late evening, as the Megger is found to be very sensitive to humidity changes. The average time required to test all the insulators on a double circuit steain tower (84 disks) is from 25 to 40 minutes. Suspension towers take slightly less time.

To-day it can be claimed that this vital element of a transmission system, the insulator, has emerged from the

experimental period of its development, when the success or failure of a particular insulator depended largely upon luck. The principles of design, operation and maintenance are now nearly as definitely determined as those of any other unit of the system. Although there are some tests that are not altogether satisfactory and differences of opinion exist regarding the meaning of others, nevertheless there are tests which are most useful and fundamental, and the operating engineer no longer needs to buy insulators blindly. After a line is in service, the task of keeping it in first-class condition is no more a matter of chance than that of maintaining other apparatus, and line failures in large number are really an indication of negligence in maintenance.

In another paper, by A. O. Austin, it was pointed out that flashovers seemed to tend to increase with the size of the system. A theory was advanced to account for this which was illustrated by a number of interesting photographs of flashover tests at very high pressures. Mr. Austin has discovered that since an insulated control system improves the flashover voltage for any combination of frequency, its application promises to eliminate much of the trouble now existing on systems subject to arcs.

### Cables.

Cables received very little attention at the Paris Conference. Messrs. P. V. Hunter and E. B. Wedmore presented a paper which contained a lot of interesting information concerning the heating of cables. The subject matter has, however, already been dealt with in the English technical Press and in reports of the I.E.C. Mr. H. W. L. Bruckman contributed some notes dealing with the differences in tests of sample lengths and long lengths of cable, and in particular the resistance of the insulation. Messrs. F. A. Smit Kleine, C. F. Proos, and J. C. van Staveren presented a joint report upon the work of the Dutch standardisation commission. The most interesting feature of this report was the suggestion that in addition to the ordinarily accepted tests, an ionisation curve should be included.

*(To be continued.)*

## THE WORKMEN'S COMPENSATION (No. 2) ACT.

By JOS. J. H. STANSFIELD.

In an article which appeared in the Electrical Review dated December 7th, 1923, some of the alterations made by the new Act were dealt with, but the Act is lengthy and of such importance that certain matters had to be left out in consequence of the limited space available. These additional notes should therefore be read in conjunction with what has already appeared.

### Increase of Amount Payable at Death.

Under the 1906 Act all weekly payments which had been made prior to the death of the workman were deductible, and it therefore might happen, where a long illness arising out of the accident preceded the death, that no compensation was payable.

Under the new Act a minimum of £200 is payable on death if there are dependents, irrespective of the weekly payments made during the illness, and in addition to this, the full sum is payable on behalf of the children; that is to say, that no weekly payments which may have been made shall be deemed to have been made so as to reduce the compensation payable in respect of children who are dependents.

It therefore follows that, although the maximum amount payable to dependents on death is £600, the amount paid in a case which terminates fatally may exceed £600 where weekly payments have been made during the incapacity which preceded the death.

### Accidents Outside Scope of Employment.

Under the Act of 1906 no compensation was payable unless the accident arose out of, and in the course of the employment, and where a workman had acted in contravention of statutory rules and regulations or orders, it was deemed to be an accident not liable for compensation.

It is now provided that compensation is payable in the case of death or serious and permanent disablement if the act was done "for the purpose of, and in connection with, the employer's trade or business."

There can be little doubt that this extension will lead to litigation to decide what is serious and permanent disablement and whether the act was for the purpose of and in connection with the business.

### Extension of Definition of Workmen.

The 1906 Act excluded non-manual workers if their earnings exceeded £250. This has now been increased to £350. In the analysis of wages required where compensation payable is covered by a policy taken out with an insurance company or mutual benefit society, it will be necessary to include an increased number of non-manual workers, such as clerks, draughtsmen, storekeepers, and others.

### Compensation to Minors.

In the case of permanent incapacity, an employer has the right to commute the payments. Under the 1906 Act this is to be done on the basis of the compensation paid during the six months following the accident, and in the case of minors it might therefore be on a low basis, but it is now provided that prospective earnings can, with minors, be taken into consideration.

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**American "Electric Fleet" Complete.**—The U.S.S. *West Virginia*, last of the battleships to be built by the United States Government under the Washington Armaments Conference and the sixth to be equipped with electric drive, thereby completing the "electric fleet," was to be commissioned at the Newport News shipbuilding yards about December 1st. She will be a sister ship to the *Maryland* and the *Colorado*. According to the *Electrical World*, the *West Virginia* is electrical throughout. Her main propulsion machinery consists of two Curtis steam turbo-generators, designed to develop 12,600 kW at a speed of 2,150 r.p.m., and driving the ship at 21 knots. These supply power to four 8,000-h.p. General Electric induction motors, directly connected with the four propellers and turning at 177 r.p.m. The motors, among the largest ever built, are 12 ft. in diameter and weigh 62 tons; the 32,000 h.p. thus available for propulsion purposes is enough to supply power to a city of 100,000 population. The two turbo-generators, supplied with steam generated by eight oil-burning boilers, can be run independently. Either is capable of driving the ship up to a speed of about 17 knots. The power generated by them is used for no other purpose than propelling, electric current for other needs being generated by six 300-kW generators and two 400-kW Diesel sets. Virtually every electrical appliance used afloat and ashore has been installed in this new battleship. The electrical equipment includes radio-telegraphy, loud-speaking telephones, ordinary telephones, gyroscope compass, steering gear, anchor windlass, capstan, boat cranes, winches, air compressors, air heaters, turret training, turret-gun elevating, ammunition hoists, gun firing, range signalling, powder-testing oven, ice machines and much besides.

**Another Mercury-Vapour Boiler.**—Power from mercury vapour, making possible a double vapour plant in which turbines for generating electricity are driven both by mercury vapour and water vapour from the same fuel source, is the outstanding achievement claimed for a new boiler produced by the General Electric Co., of Schenectady. According to Mr. W. L. R. Emmet, inventor of the new system, the mercury boiler is over 50 per cent. more efficient than the best steam plant. Mr. Emmet estimates that if the mercury boiler comes up to all expectations, it will produce with 35 lb. gauge pressure, compared with a steam turbine generating plant which uses 200 lb. steam pressure, about 52 per cent. more output of electricity per lb. of fuel. The process involves the vaporisation of mercury in a boiler, driving a turbine by the mercury vapour, and the condensation of the exhaust in a condenser where its latent heat is delivered to water and thus used to generate steam at a pressure suitable for use in existing steam plant.—*Reuter's Trade Service* (New York).

# NEW ELECTRICAL DEVICES, FITTINGS, AND PLANT.

*Readers are invited to submit particulars of new or improved devices and apparatus, which will be published if considered of sufficient interest.*

### The "Gravity Auto-Mechanical" Fire Alarm.

As the inventor claims that electrical apparatus has been eliminated as far as possible, it would seem that the "Gravity Auto-Mechanical" fire alarm, recently demonstrated at the offices of the Institute of Patentees, had no claim upon our space. The invention however, has certain possible applications in the electrical world, and for that reason alone is worthy of mention.

The apparatus is very simple, and its operation straightforward. The actual operative portion is a composite ring consisting of two flat rings with a thin brass collar. Fusible metal is moulded over the collar retaining the flat rings by means of narrow ridge. Between the flanges thus formed a metallic stranded cord is looped over twice. The cord is anchored at one end and carried across the ceiling of the room which is to be protected, over pulleys, terminating in an indicator box where a weight is affixed to it. It will be seen that the fusion of the metal in the composite ring (at a temperature of about 160 deg. F.) will cause the two flat rings to fly apart releasing the wire, and causing the weight to fall. The falling weight trips a trigger which sets in action a large bell with a clockwork-operated hammer. At the same time a telephone transmitter placed close to the bell sends by means of an intermittent contact arrangement the noise of the bell—converted into a code number—to the public telephone exchange. The operator upon receiving the signal immediately plugs through to the fire station, which acts upon the message thus received, being in possession of the code which indicates the scene of the fire. A development of the alarm for application to coal stacks, ships' cargoes, &c., is illustrated in fig. 1. In this case the wires are encased in a flexible metallic tube, while the rings are covered by stiff metal cylinders. Otherwise the system is as described. The device is made by the "Gravity" Automatic Fire Alarm Syndicate, Electra House, Moorgate, E.C.2.

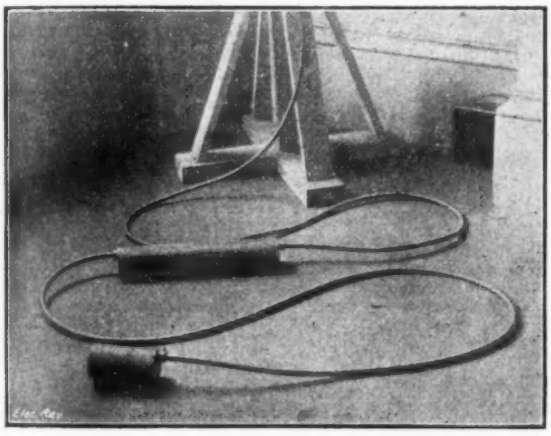

Fig. 1.—Fire Alarm for Coal Stacks, &c.

### The "Losles" Thermostatic Circuit-breaker.

A reliable thermostat lends itself to an extraordinarily wide range of applications, from frying fish to hatching chickens or ripening bananas; by no means the least important of these is the maintenance of uniform temperature in living rooms and offices. Mr. George Wilkinson, M.I.E.E., of Beech Mount, Harrogate, who has for many years studied heat economy in a variety of cases, and some years ago developed a very efficient thermostat for controlling gas cookers, gas fires, &c., has now applied the methods which he has thus proved satisfactory to the electrical field. His thermostat, which is practically identical with the type of which he has had long experience, is based upon the expansive force of saturated vapour, the latter being hermetically enclosed in a phosphor-bronze bowl covered with a strong but flexible metallic diaphragm. The movements of the diaphragm, in accordance with the temperature of the surrounding air, are transmitted to the regulating mechanism by a vertical metal rod. Thus far the operation of the device is wholly mechanical, and the controller is equally applicable to any type of heating apparatus except, of course, those using combustible solids.

In the case before us the controller actuates a small circuit-breaker, which, though smaller than one's thumb, is capable of interrupting a current of 15 amperes at 500 volts; it consists of an elongated glass bulb partly filled with mercury, in an atmosphere of inert gas. Platinum leading-in wires make connection with the mercury, and a small porcelain cup is fixed inside the bulb. When the breaker is tilted by the action of the controller, the pool of mercury splits across the edge of the cup; the break is instantaneous, owing to the surface tension of the mercury, and the cup absorbs the heat produced by the momentary arc, which otherwise might crack the glass. Mercury-in-glass switches, of course, are not new; but this particular pattern has been successfully used by Mr. Wilkinson in other apparatus for over ten years.

The device is used in the winter for controlling electric fires, &c., being capable of keeping the temperature of a room constant within 2 deg. F.; in the summer it is made equally applicable for cooling by controlling electric fans or other ventilators, by simply reversing the platform on which the breaker is mounted, so that a rise of temperature causes it to make circuit and a fall in temperature to open circuit. In all seasons of the year the thermostat is suitable for controlling electric cookers, hot-water supply, and industrial operations requiring constant temperature, and it can readily be adjusted to any desired temperature within its range. As it is put in series with the circuit controlled, no relays are necessary. The "room" type is made to carry 10 or 15 amperes at any pressure up to 250 V, and is illustrated herewith, the controlling element being at the bottom of the instrument, which measures about 4 in. x 6 in. high. The device is made by Mr. Wilkinson, of the above address, and his licensees, the Electrical Construction Co., of Leeds. It is hardly necessary to point out that, by using only exactly the amount of heat required for a given purpose, a very considerable economy can be effected; and that is an important feature of the thermostat.

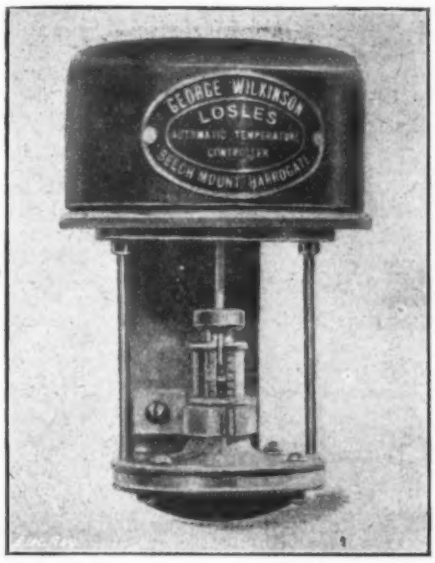


Fig. 2.—"Losles" Thermostatic Circuit-breaker, Room Type.

### The "Claristal" Receiving Set.

We have received from Messrs. Ward & Goldstone, Ltd., of Frederick Road (Pendleton), Manchester, a sample of their "Claristal" B.B.C. receiving set, which consists of a tuning coil and slider, a crystal detector fitted with the "Sonyte" crystal, and the necessary terminals. The slider is actuated by a screwed rod giving smooth and fine adjustment, and the detector is provided with adjustments enabling the whole of the exposed surface of the crystal to be explored with the "cat's whisker," though it is claimed that the "Sonyte" crystal is super-sensitive all over. The set is neatly mounted in a vertical position on a circular baseboard, and is sold at a low price. We have tested the sample on the London transmission, and find it very efficient and easy to manipulate.

### Inductance Drive.

In our last issue we published a note under the above heading drawing attention to inductance wire supplied by Messrs. Leslie Dixon & Co. Although we had not previously seen wire exactly the same as this we are assured by Messrs. Ward & Goldstone, Ltd., that they have made this class of wire for many years.

## THE APPLICATION OF SCIENTIFIC ILLUMINATION IN PRACTICE.

### An Illuminating Engineering Society Discussion.

At the meeting of the Illuminating Engineering Society, held on December 11th, over which Mr. L. Gaster presided, a discussion on the above subject was opened by Mr. G. Herbert and Mr. R. A. Ives.

It was pointed out that knowledge of the principles underlying good lighting was much more widespread than in the past. The need of eliminating glare and the importance of the precept "light on the object, not in the eye" was much better realised. The term "foot-candles" was now tolerably familiar, and a variety of simple instruments for measuring illumination had been introduced. Statistics of many kinds were available showing the relation between lighting and accidents and the part played by good illumination in preventing spoilage of work. Authentic information of that kind afforded valuable "ammunition" for those concerned commercially with lighting developments.

The authors next proceeded to answer in simple terms the query: "What is good lighting?" pointing out that good lighting was satisfactorily defined by the Home Office Committee's recommendations, involving a sufficiency of light, reasonably uniform illumination, and the absence of glare, flicker, or troublesome shadows. The determination of the amount of illumination necessary for various processes was a problem of some difficulty. It was very satisfactory to learn that the Home Office Factory Department was paving the way for such standards by arranging conferences with the chief Joint Industrial Councils of the industries concerned. It was most necessary to have, not only the amount of illumination, but the main principles of lighting defined by a recognised authority.

The next point mentioned was the importance of uniformity of practice by lampmakers with regard to sizes and dimensions of lamps. All predictions of illumination were based on polar curves of light distribution, and those, in turn, depended on the correct position of the filament within the reflector. Variation in dimensions of lamps of the same wattage, especially the distance of the centre of the filament from the cap, distorted the polar curve, and rendered accuracy of prediction of illumination uncertain. It might also defeat the efforts of the designer of reflectors to supply the public with a useful commodity.

In conclusion, the authors gave some account of experience in approaching consumers. Information offered to the average consumer must be shorn of technicalities. The wholesale distributor, the electrical dealer or contractor, and the central station engineer should, however, know enough about the technical side of the subject to enable them to interpret it in convincing language to the consumer.

Following the introductory paper, which was read by Mr. G. Herbert, a series of demonstrations was given by Mr. R. A. Ives. Several of them were designed to show how readily the eye might be deceived, and there was also a pleasing exhibit illustrating how a pattern invisible by ordinary light can be revealed by ultra-violet rays.

The subsequent discussion was opened by Mr. J. S. Dow, who explained how the author's desire for "ammunition" was being met by scientific tests and the collection of statistics undertaken in co-operation with the London Safety First Council, the B.I.S.F.A., and other bodies. Such data must be prepared on a scientific basis and be backed by a recognised authority. Mr. Dow also referred to various future prospects of useful educational work before the Society, which could only be brought to fruition if suitable support was forthcoming, and emphasised the important *rôle* which this country, the first in Europe to form an illuminating engineering society, should play in the future.

Amongst others who spoke, Mr. W. R. Rawlings alluded to the importance of a general knowledge of illuminating engineering on the part of electrical contractors. Mr. Haydn T. Harrison expressed adherence to higher values of illumination than had been hitherto customary, a view that was also supported by Mr. W. E. Bush. Capt. Stroud, on the other hand, thought that 10 foot-candles should suffice for almost all processes. He agreed as to the importance of companies having men trained in illuminating engineering, and mentioned that the firm with which he was associated had been among the first to initiate periodical conferences and lectures in various parts of the country, in which information presented at the Society's meetings was made widely known.

Mr. G. Campbell, Mr. J. G. Clark, and Mr. J. F. Caine also took part in the discussion. The chairman, after a few concluding remarks, announced that the next meeting on January 22nd would be devoted to "Research in Illuminating Engineering."

## CORRESPONDENCE.

*Letters received by us* **after 5 p.m. on Tuesday** *cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.*

### Electrical Apathy v. Gas Enterprise.

We are enclosing herewith copy of a letter received from the secretary of the Charing Cross, West End, and City Electricity Supply Co., in answer to a request for heating and cooking supply for the writer's flat in Charing Cross Road.

The reply indicates that the consumer must interview the landlord of the property and then bear the cost of running his own mains before the Electricity Supply Co. will connect up.

It is well known that well over 75 per cent. of the consumers who make similar applications to this and other companies and receive this kind of reply do not carry the matter any further. Most of them communicate with the gas company, which will at once supply them and, what is more, rent them all the most modern cooking and heating appliances at a trivial quarterly charge.

In this manner tens of thousands of pounds per annum are diverted from the electrical industry into that of gas. Is it surprising that our industry is suffering so seriously? The Electricity Supply Co. has the monopoly, and one must quietly go without the electrical home of which certain sections of the Press are boasting at the present time.

Wishing the Electrical Review continued success,

**R. Egerton-Green, Ltd.**
R. Egerton Green,
*Managing Director & Secretary.*

London, *December 15th*, 1923.

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[Copy.]

Referring to your letter of yesterday's date, the rising mains in the building are taxed to their utmost capacity, and it would not be possible for us to connect up any heating or cooking supplies unless wires were run from your flat to our terminals in the basement.

Should you contemplate doing this, I would advise you to see the agents for the property.

Yours faithfully,

*For the* **Charing Cross, West End & City Electricity Supply Co., Ltd.**
(Signed) Cecil J. Stanesly,
*Secretary.*

R. Egerton-Green, Esq.

### Delayed Deliveries.

Referring to your article "Delayed Deliveries," I may perhaps be allowed to state my views on this all-important matter.

Orders, at present, are by no means plentiful, and consequently every firm wishes to succeed in getting the order for which it may be quoting. Its price may be O.K., but it knows that, in the greater number of cases, its deliveries must also be short; consequently, a "time of delivery" is quoted which is generally much too short to allow for the many contingencies which always seem to crop up on rush jobs.

If a firm quotes a delivery of, say, two to three weeks (which it knows it can keep), it stands every prospect of being beaten by a firm promising delivery in, say, 10 days, which promise, though it may secure the order, is but seldom fulfilled.

As has already been said, a succession of delayed deliveries does a firm no good, but there is a very great number of firms which secure orders on account of their promises of short deliveries, which they know full well they cannot fulfil.

The consequence is that the more reputable firms have either to allow many orders to pass them, or alternatively, to resort to promises, the fulfilment of which they know is very improbable, but which, on the other hand, may be the deciding factor in securing orders for them.

Not until customers learn to differentiate between firms that give fair promises and keep them, and firms that make rash promises followed up by plausible excuses, will the number of overdue orders be appreciably lessened.

Wishing the Review continued success,

**F. B. J. S.**

*December 16th*, 1923.

### The Postmaster-General and Electrical Power and Lighting Undertakings.

I ask your readers to agree with Mr. Bartholomew that I knew and still know nothing of injurious disturbance of well spiralled telephone circuits by reason of adjacent power lines at pressures of about 3,300 volts, and at a distance of about 40 ft., the conditions under which the Post Office claimed there would be interference. It is my case that the Post

Office is in error, and that there would be less interference than from a low-pressure line carrying the same power, to which the G.P.O. would have raised no objection. Further investigation has convinced me that there will be no appreciable static effect from the line we will construct, and I am prepared to demonstrate this to any impartial person, and that the Post Office objection should be withdrawn.

Mr. Bartholomew's claim that the G.P.O. has "always" been reasonable and considerate can be dealt with by each reader testing its probability by reference to his own experience with the G.P.O. For instance, some readers may have wanted the position of their telephones altered or questioned the telephone call account, or tried to get compensation for a lost or damaged parcel. Others may have had correspondence with the Post Office asking for some concession or variation from the existing standard to meet a special case. Will those readers who have "always" found the G.P.O. to be flexible and willing to fall in with their wishes please write and say so? I am sure Mr. Bartholomew will be pleased at the result of his appeal on the 7th, and mine to-day.

**W. Fennell.**

Northwich, *December 14th*, 1923.

### A Non-technical Explanation of "Power Factor."

I have pleasure in announcing that Mr. S. T. Allen, M.I.E.E., chief engineer and general manager of the Wolverhampton electricity department, has kindly consented to act as adjudicator in the competition for a non-technical explanation of "power factor."

**R. Amberton,**
*Director, Electrical Apparatus Co., Ltd.*

London, *December 15th*, 1923.

### Electricity in the Mining Industry.

A study of the notes on accidents due to electricity, by H.M. Electrical Inspector of Mines, published in recent issues of the Electrical Review, appears to indicate the existence of a certain amount of inefficiency and even incompetency in the use of electricity underground. The accidents are reported as being caused by defective apparatus, inadequate repairs, and careless handling of h.p. apparatus. Some years ago, the writer, when connected with colliery work, was struck by the questionable intelligence and capability of the average type of underground electrician, and by the absence of proper supervision.

With the adoption of h.p., a.c. in mines operated under more severe conditions than elsewhere, it is reasonable to suggest that the colliery electrician should possess the maximum of intelligence and experience. In the electricity supply industry elaborate precautions are taken for the protection of men working on h.p. apparatus, but the Report conveys the impression that underground the electrician is given a free hand and the machine-man is allowed to interfere with apparatus working at 500 volts, a.c.

Perhaps such impressions are wrong, and it would be satisfying to many to hear what those directly connected with the mining industry have to say.

**M. E. B.**

*December 12th*, 1923.

### The Prospects in New Zealand.

Can you, or a reader of the Review, give me any information regarding the prospects for electrical workers in New Zealand, Wellington district, or other parts of the Dominion?

**Diverter.**

*December 17th*, 1923.

### Tendering for Electrical Contracts.

One of your contributors, Mr. E. A. R. Paton, is not the only one who is wondering what has gone wrong recently in tendering for electrical contracts.

He specifically mentions an installation of electric lighting and power at the new premises for a large retail store in Liverpool, and as one who tendered for this work, I should like to take the opportunity of placing before your readers a few facts, which will add a larger query to the subject. For instance:—

| | |
|---|---|
| Switchboard at makers' quotation ... ... ... | £226 |
| Main cables ... ... ... ... ... ... ... | 202 |
| Motor-generator ... ... ... ... ... ... | 99 |
| 25 flood lights ... ... ... ... ... ... | 137 |
| 15 fuseboards (with over 100 ways), say ... ... | 50 |
| Five radiators, say ... ... ... ... ... | 25 |
| 576 lights, each light for 500 watts controlled by 400 odd switches, say £1 per light material ... ... | 576 |
| Mains from switchboard to 15 distribution boards, say ... ... ... ... ... ... ... | 320 |
| Makes a total of ... ... ... ... ... | £1,565 |

In addition to the above total amount, there are flat-iron circuits, cash-register circuits, bell circuits, pilot-light circuits, and radiator circuits not accounted for in the above figures; all cable has to be Association made, all tubing to be screwed, and some labour will be required to erect the above.

I wonder where the catch is?

**H. Jones.**

Liverpool, *December 11th*, 1923.

Letters have been received, too late for insertion this week, from Mr. Roland A. Hill, Davis Electrical Co., Ltd., Mr. W. F. Higgs, and "A Stitch in Time."

## REVIEWS.

**The ABC of Atoms.** By Bertrand Russell, F.R.S. Pp. 192. London: Kegan Paul, Trench, Trubner & Co., Ltd. Price 4s. 6d. net.

The author of this small book is best known to the public by his "Introduction to Mathematical Philosophy," which has achieved a world-wide reputation. The reader, however, need not be deterred from perusal of this simple account of atomic constitution by any apprehension of mathematical difficulties. The author employs his mastery of mathematical theory for the purpose of avoiding any employment of mathematics. There is scarcely an equation to be found in it. Some of the matter it contains appeared earlier in the year under the title of "The Structure of the Atom" in "The New Leader." The treatment the subject there received has been very much expanded, and is well adapted to acquaint a person, ignorant of physics, with the views now held as to the nature of matter and how it has come to be based on electricity. After a short general introduction, the periodic law is explained with its modern developments. Electrons and nuclei are then dealt with, and the hydrogen spectrum introduced. The possible states of the hydrogen atom are then explained by the light of its spectrum, and the nature of *quanta* is described. In the last chapters, X-rays, radioactivity, and the undulatory theory of light are examined, and the book ends with a chapter on applications of the theory of relativity to the new forms of structure now imputed to the atom. In a short appendix of three pages a few simple equations appear, but alas! their lucidity is obscured by one or two misprints—trifles, but stumbling-blocks to the neophyte, for whom the book is intended.

**The Structure of the Atom.** By N. R. Campbell. Supplementary chapters. Pp. x+161; figs. 6. London: Cambridge University Press. Price 10s. net.

This is chapter XVII of "Modern Electrical Theory," and well maintains the high standard of lucidity with which recent developments of research have been set forth in the former supplementary chapters of this admirable work. The subject is in this case of exceptional importance, because the foundation-stone of modern electrical theory is the constitution of the atom; there are some aspects in which the atomic structure may more properly be likened to the keystone of the arch; but from any aspect, the theory is held together by the views that have been formed as to the nature of the atom. Of the great tree of physical science, this is now the bud—the place of maximum growth, where the whole energies of the plant are concentrated in order to lead the way into a new space. The workers are multitudinous and enterprising; so many are contributing to progress that the author confesses, in his preface, to some misgivings as to attribution. His general principle is to mention names only where the readers are sure to meet with them in the original memoirs which he desires them to wish to consult; but here such a number of people have been occupied with the same ideas; he has supplemented it with the further principle that the proper author of an idea is the person who first applies it successfully to the explanation of facts. Thus atomic theory would begin with Dalton and not Pythagoras, and this, for the purposes of science, is the only rational view to take. After a brief introduction dealing with the Rutherford-Bohr atom, atomic number, isotopes, and classification of atomic properties, the problem of the nucleus is brought forward under three headings: (i) the charge on the nucleus, (ii) the mass of the nucleus, and (iii) the structure of the nucleus. Section II deals with the extra-nuclear electrons, and section III with combinations of atoms.

Of course, the budding point of science is always the most interesting point, but never was there so interesting a bud as that now opening; what sort of foliage or flower is to emerge is even now far from clear; or to adopt another metaphor, nature appears to have set a jig-saw puzzle of which the complete picture is a piece of mechanism of an entirely new kind, working on principles never before introduced; a lot of people are engaged upon it, and weekly, almost daily, discovering new details of a surprising character; and the contributors are so numerous that the author is obliged to acknowledge that an adequate presentation requires more time for study and greater width of information than he can compass. It is a privilege to assist, even as an onlooker, in such a piece of work. Take, for example, the item contributed by Ramsauer, who measured the mean free path of electrons moving with the speed of a few volts through various gases. He found that with some of the rare gases, particularly argon, as

the velocity is decreased, the free path is lengthened; so that the centre of an atom is approached more closely by a slow moving electron than by a fast: it is a strange piece of mechanism that can work like that. Magnetic moments are another puzzle. Bohr meets them with a denial that an electron revolving in a quantum orbit has any magnetic moment.

The book is rather a discussion than an exposition; seeing that so many features of the emerging picture are still a matter of conjecture, it could hardly be otherwise. The search for the mechanism of valency is as thrilling as that for the mechanism of any sensational crime as set out by the current fiction-mongers. In the proceedings of the scientific societies and technical Press, a feuilleton is proceeding by the collaboration of many hands, the dénouement of which cannot be reached for years, so the excitement is of an enduring kind for those who have the mind to feel it. Some compounds of the *polar* kind, of which NaCl is a type, may be supposed to hold together as the consequence of electrostatic attraction between atoms bearing resultant charges of opposite sign; in this view the distinction between chemical and physical forces disappears. Other compounds of the non-polar kind, of which the molecule $O_2$ is a type, are supposed to hold together by the sharing of electrons between adjacent atoms. To reconcile the two models seemed impossible, but it is now believed that no two electrons revolve in the same orbit, and where they revolve at equal distances from the nucleus they occupy different planes; so reconciliation is sought on the assumption that sharing an electron means sharing in the orbit of an electron. Still, even on the best outcome for this hypothesis, there remains the mystery of NO (nitrous oxide), which seems quite insuperable; neither the Rutherford-Bohr model nor the Lewis-Langmuir model accounts for its peculiar constitution and stability.

The book is well written, and discussion of the subject it treats of is carried on in a very clear manner; the greater part of it is easily followed by anyone generally acquainted with the subject. It is to be feared that many of these will miss the pleasure its perusal might afford by dread of a tax upon their attention. There is a certain amount of mathematical reasoning, not very much, none of which is difficult, and even that may be skipped. Ninety-five per cent. is very interesting reading-matter simply expressed, designed to put the reader in touch with the mystery-hunt of modern times, and may pleasurably occupy the leisure of anyone familiar with the groundwork of the subject.

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**Electrical Engineering Practice.** Vol. I. By J. W. Meares, C.I.E., F.R.A.S., and R. E. Neale, B.Sc. (Lond.). Pp. x+584; illustrated. London: Chapman & Hall, Ltd. Price 25s. net.

In the "Spoon River Anthology," a work well worth perusal by engineers, one Frank Drummer sets out to memorise the "Encyclopædia Britannica," and ends up in a padded cell. A hasty perusal of the book under review gave the impression that the authors were following in the footsteps of the hapless Frank. This impression was due to the vast numbers of references to, and extracts from, I.E.E. papers and other works which are given in the volume. These also tend to give the reader the idea that all that is necessary to produce such a book is to make wholesale abstracts from the technical Press and classify them under any convenient headings.

More patient and careful reading showed that they had really achieved to a very creditable extent what they had set out to do, namely, to give a general outline of the whole field of practical electrical engineering. That this is the verdict of the reading public is proved by the fact that the work has reached a fourth edition.

Having confessed to, and apologised for, a somewhat unfavourable initial impression, it remains for the reviewer to give a short description of the various sections of the work.

*Part I.—Definitions, Materials, and Measurements.*

The summary of definitions and elementary principles of electrical engineering is very useful and concise, and the abridged tables of standard symbols and diagrams should also be appreciated by busy engineers.

The descriptions of materials of construction used in electrical engineering are very up-to-date, but they seem to be rather the productions of close students of the electrical Press than of men intimately engaged in working with them.

A fairly comprehensive treatment of commercial measuring instruments is given. The explanations of the working principles of some of the instruments are, however, somewhat scrappy, as in the case of the Aron watt-hour meter, and of induction watt-meters. The statement on page 153 that the mercury motor watt-hour meter "is not suitable for a.c. measurements because of the high inductance of the pressure circuit," was surely not very carefully considered by the authors. The bibliography saves this part of the book.

*Generators and their Accessories.*

This chapter summarises the means by which electrical energy is made available. It contains much useful information, but does not do full justice to the subject, which is obviously one of the most important in electrical engineering.

*Power Factor and its Improvement.*

This is one of the clearest explanations of the subject which have yet come to the reviewer.

*Sources of Energy and Prime Movers.*

A great amount of interesting and useful information is given in this chapter. It includes summaries of all the latest developments which have been disclosed in the technical Press. The bibliography contains no reference to work on the gas turbine.

*Power Plant Development and Data.*

The authors have succeeded in providing a great amount of valuable data of power station costs and efficiency, and on space occupied by the different parts of the plant. The chapter would have been improved by a few good drawings showing typical "lay-outs" of plant, with dimensions.

*Water Power.*

The sections on water power are very interesting, and are more complete than any of the preceding ones. They form a very convenient introduction to hydraulic engineering.

*Maximum Demand, Load Factor and Diversity Factor—Electricity Costs and Tariffs.*

The fundamental principles of the sale of electrical energy are dealt with in two short sections. These are of great interest and importance, and it is unfortunate that they are so condensed. The examples of tariffs which are given show the chaotic state of the British electricity supply industry in this respect.

*Insulated Wires and Cables—Transmission of Power.*

While these sections are in no way novel, they give a very practical outline of electrical transmission systems, and of the formulæ and data used in every-day practice. The notes on quarter and half-wave transmission are interesting, and although there does not seem to be much likelihood of the systems being adopted in ordinary engineering practice, they are well worth close perusal.

*Protection of Circuits and Apparatus.*

The general effects of short-circuits on a.c. networks are described, and short notes on the best known discriminative protective systems are given.

*Switchgear and Switchboards.*

This chapter gives a short description of the main classes of switchgear used in Great Britain.

The publishers and printers have done their work well.

In conclusion, the reviewer must congratulate the authors on the great industry they have shown in collecting and classifying such a mass of useful information. It is hoped that the appearance of the second volume will not be long delayed.

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**Atoms.** By Jean Perrin. Pp. xv+231; figs. 16. London: Constable & Co. Price 8s. 6d. net.

This is the authorised translation by D. Ll. Hammick, based on the eleventh French edition, which has been specially revised and supplemented for the occasion. It deals not so much with the structure of atoms as with the behaviour of atoms in bulk, molecular agitation and Brownian movements. There are chapters on light and quanta, also on the atom of electricity, which are treated of as bearing upon the main thesis of the work, that is to say, the marvellous way in which the results of many and diverse lines of research have led to identical conclusions, or almost identical conclusions, concerning the mass, magnitude, velocity, and other attributes of molecules. It can be asserted with perfect confidence, in the words of the author, that each molecule of the air we breathe is "moving with the velocity of a rifle bullet; travels in a straight line between two impacts for a distance of nearly one ten-thousandth of a millimetre; is deflected from its course 5,000,000,000 times per second, and would be able, if stopped, to raise a particle of dust just visible under the microscope, by its own height. There are 30 milliard milliard molecules in a cubic centimetre of air, under normal conditions. Three thousand millions of them placed side by side in a straight line would be required to make up one millimetre. Twenty thousand millions must be gathered together to make up one thousand-millionth of a milligramme."

These facts are based on cumulative evidence, the weight of which may be gauged by an example given at the end of the book (it is, in effect, a summary of its contents), in which computations of Avogadro's number, from no less than sixteen sources, are assembled. N, the number of molecules in a gramme-molecule is about $65\times10^{22}$. Calculated from the viscosity of gases, it is 62; from the vertical distribution in dilute solutions, 68; from the vertical distribution in concentrated solutions, 60; from Brownian movements of displacement, 64; from Brownian movements of rotation, 65; from Brownian movements of diffusion, 69; from density fluctuations in emulsions, 60; from critical opalescence, 75; from blueness of sky, 65; from diffusion of light in argon, 69; from black-body spectrum, 61; from charge of microscopic particles, 61; from projected charges in radioactivity, 62; from helium produced thereby, 66; from radium lost, 64; from the energy radiated, 60; which is marvellous testimony to the virtue of kinetic theory. The author adds the very wise caution: "We must not, under the pretence of gain of accuracy, make the mistake of employing molecular constants in formulating laws that could not have been obtained without their aid"—a mistake people are only too apt to fall into. The perspicuous system of presentation of fact and argument, traditional with the French, is well preserved in the translation, and the book is quite easy to read.

# BUSINESS NOTES.

**Earlier Publication of the "Electrical Review."**—For many years it was our custom to publish the Electrical Review so that it could be in the hands of the reader first thing on Friday morning. Under the difficult conditions which arose several years ago, circumstances beyond our control made it necessary for us to depart from that arrangement. It has been our intention to revert to the former printing hours at the earliest convenient moment, for we have been fully aware of the desire of many readers to avail themselves of the information given in some of our regular sections well in advance of the week-end.

We are glad to be able to announce that our long-deferred hope is about to be more than realised, for commencing with the first issue in the New Year (Friday, January 4th, 1924) all of our United Kingdom subscription readers outside London will have their Electrical Review delivered to them by the first post on Friday morning. Those ordering their copies through newsagents should be supplied at about the same time.

Subscribers in the London Postal District should receive the Review late on Thursday night, instead of by the last post on Friday as at present.

We believe that this further effort on our part to meet the convenience of our readers, and the requirements of the trade, will meet with general approval.

No effort will be spared to ensure that the up-to-date character of the week's news and the general contents of the journal shall be maintained, and we invite the co-operation of all correspondents and contributors to that end.

**Bankruptcy Proceedings.**—Charles Augustus Carpenter, 4 and 5, Mason's Avenue, Basinghall Street, London, E.C., electrical engineer.—An application was made to Mr. Registrar Mellor at the London Bankruptcy Court on December 12th for an order of discharge on behalf of this bankrupt, who failed in June, 1921. The Official Receiver (Mr. E. Parke) reported that the provable debts amounted to £1,580, and no assets were disclosed, nor had any been realised. After carrying on business at 4, Maidenhead Court, E.C., in partnership with another person, from October to December, 1913, the bankrupt and his partner sold it to a limited company, which went into voluntary liquidation in 1914. The bankrupt thereafter carried on a similar business at the same address, and in 1916 he was joined by a partner who introduced £200 capital; in June, 1917, he surrendered the business to his partner, and became managing director of a limited company formed to acquire a fire alarm, which he had invented and patented. In June, 1918, he recommenced business as an electrical engineer at 4-5, Mason's Avenue, E.C., and for a few months in 1919 had two partners, who retired. This business, owing to his ill-health and labour troubles, was unsuccessful. In March, 1921, he transferred, in consideration of £1,998 in shares and his appointment as managing director at a salary of £7 a week, the whole of his business assets to C. A. Carpenter, Ltd., a company whose entire capital was only £2,000, and which did not take over his trade debts; before the formation of this company his brother had lent him £1,200 to pay debts of the business on the understanding that he was to receive for such advances £1,200 in shares of a company when formed; and in pursuance of this arrangement 1,200 of the bankrupt's 1,998 shares were allotted direct to his brother. The bankrupt attributed his insolvency to ill-health, labour troubles, and lack of capital. He had admitted that the result of his having transferred all his assets to C. A. Carpenter, Ltd., for shares (most of which were handed over to his brother) was that his creditors had been thereby deprived of the power of attaching any of the assets, but he submitted that the creditors received the benefit of his brother's £1,200 cash. Apparently out of the said sum the bank received £500 to clear an overdraft, and the creditors received *pro rata* a share of a further £500. The whole of the bankrupt's present indebtedness was in respect of goods supplied and work done, and moneys borrowed for the purposes of the business. The creditors were not informed of the transfer of the assets to the company until three weeks thereafter. The bankrupt subsequently started business at 11 and 12, Rose Street, Newgate Street, and arranged to take over the company's maintenance contracts estimated to produce £500 per annum, and shortly afterwards the company ceased to do business. The offences reported by the Official Receiver were (1) insufficiency of assets to equal 10s. in the £ on the amount of the liabilities; (2) trading with knowledge of insolvency; and (3) misconduct in transferring all his assets to a company on terms beneficial to himself, but most damaging to his creditors. Mr. Kingham appeared for the bankrupt, and asked for the discharge to be granted subject to a small judgment. His Honour upheld the Official Receiver's report, and imposed a suspension of two years and six months.

G. W. Taylor, South View, London Road, Fletton, electrical engineer.—The public examination of this debtor took place recently. The deficiency was put at £229, there being liabilities of this amount and no assets. Debtor stated that his position was due to losses on contracts owing to the fluctuations in the cost of materials. He had stopped trading six months previously and had since been employed as an electrician by a firm.

**Company Liquidations.**—Lumens, Ltd., electrical and wireless engineers, 12-14, Great Ducie Street, Manchester.—Pursuant to Section 188 of the Companies (Consolidation) Act, 1908, a meeting of the creditors in this matter was held on December 11th at the Deansgate Hotel, Manchester, when the chair was taken by the liquidator in the voluntary liquidation of the company, Mr. T. Forster. The statement of affairs showed liabilities of approximately £630, while the assets were put down at £108. The liquidator stated that the purchases of the company for the 17 months ended November 23rd last were £1,681. The sales amounted to £2,058, and after deducting expenses, &c., there was a loss of £997. It was further stated that the stock had been seized under a distraint. No balance-sheets had been drawn up since the inception of the company. After some discussion it was decided to confirm the voluntary liquidation of the company with Mr. Forster as liquidator. The following are creditors:—

| | £ | | £ |
|---|---|---|---|
| H. Ashdown, ... ... ... | 14 | Radio Equipment Co. ... ... | 50 |
| Ebonestos, Ltd. ... ... ... | 12 | Hirst Bros. ... ... ... | 32 |
| Electrical Distributing Co. ... | 38 | John Moores & Co. ... ... | 36 |
| Cable Accessories Co. ... ... | 15 | Electrical Accessories Co. ... | 20 |
| Electrical Supplies, Ltd. ... | 18 | Northern Steel and Hardware | |
| T. M. C., Ltd. ... ... ... | 11 | Co. ... ... ... ... | 14 |
| British Insulated & Helsby | | Cohen & Son ... ... ... | 14 |
| Cables, Ltd. ... ... ... | 14 | B. D. S. Wireless ... ... | 14 |
| General Electric Co., Ltd. ... | 37 | K. & G. Motors ... ... ... | 19 |
| W. Deeley ... ... ... | 13 | | |

Union Electric Welding Co. (Egypt), Ltd.—A meeting of members is called for January 17th, at Messrs. Maxwell, Scriven & Batley's offices, 29, Great St. Helens, E.C., to hear an account of the winding-up from the liquidator, Mr. F. C. Clifte.

Chichester Electric Light & Power Co., Ltd.—A meeting of members is called for January 15th, at 33, Carey Street, W.C., to hear an account of the winding-up from the liquidator, Mr. V. W. Grosvenor.

Electrical Engineering & Equipment Co., Ltd.—Particulars of claims by January 31st to the liquidator, Mr. R. Kettle, 5, London Wall Buildings, E.C.

**Dissolutions of Partnership.**—Cogent Electrical Co., electrical engineers, 54, Berry Street, Liverpool.—Messrs. H. Neville, W. D. Joyce, and A. J. Singlehurst have dissolved partnership. Mr. Singlehurst will attend to debts and continue the business under the same style.

R. E. Hughes and R. McAlexander (R. E. Hughes and Hughes & Alexander), house furnishers and electrical and wireless engineers, 129, Brockley Rise, S.E., and 51, Honor Oak Park, S.E.—Trustee, Mr. A. J. W. Osborne, Balfour House, Finsbury Pavement, appointed December 10th.

G. W. Humphrey (Humphrey Electrical Co.), electrical engineer, 24, Broad Quay, Bristol.—Trustee, Mr. F. W. Darley, Official Receiver, 26, Baldwin Street, Bristol, released December 10th.

F. A. Watkins, electrical engineer, 57, High Street, Hythe, Kent.—Last day for proofs for dividend, December 31st. Trustee, Mr. E. H. Hawkins, 4, Charterhouse Square, E.C.

**Trade Announcements.**—Messrs. Lawrence & Nicholas, of 208, Chapel Street, Salford, Manchester, have been appointed agents in Lancashire and Cheshire for the Metallic Seamless Tube Co., Ltd. Large stocks of metallic conduits and fittings will be carried by them.

Mr. H. F. King, of 17, Ellers Road, Harehills, Leeds, has been appointed agent for the West Riding of Yorkshire for Engineering & Lighting Equipment Co., Ltd.

Messrs. S. Davis & Co. (publishers of the *Electrical Engineer's Year Book*) have removed from St. Swithin's Lane, E.C., to Aldwych House, Aldwych, W.C.

Mr. Charles Gates, electrical engineer, Norwich, asks us to state that he has no connection with any other electrical firm of the name of Gates.

On December 27th, Messrs. Henry Lea & Son, consulting engineers, are removing from Bennetts Hill to 1, Newhall Street, Birmingham." (Teleg. Address: "Engineer, Birmingham"; Telephone No.: Central 113.)

**Book Notices.**—"Mechanical World Year Book" for 1924. Manchester: Emmott & Co.; price 1s. 6d. net.

"*Journal* of the I.E.E." Vol. 62, No. 324.—The December issue contains the presidential and eight local chairmen's addresses, besides the usual notes and notices.

**The Christmas Spirit.**—The employés of the British Insulated & Helsby Cables, Ltd. (Prescot Works) have raised a Father Christmas Fund, and during last week were engaged in the distribution of seasonable gifts at local hospitals. Relatives of the company's employés in any of these institutions were visited.

**Calendars and Diaries.**—Messrs. Francis Poldpn & Co., Ltd., of 56, Cannon Street, London, E.C.4, are the first to send us a pocket diary for the year 1924. There are a number of pages containing tabular and other general information, and in the pocket an insurance coupon.

We have received from Collins Electrical, Ltd., a calendar with two-month sheets bearing humorous illustrations in colour by Lawson Wood.

From Messrs. John Armstrong & Co. (Manchester), Ltd., of Barton Square, St. Ann's Street, Manchester, we have received a hanging calendar with monthly slips. The pictorial feature is a pleasing study in colour of a "Girl in a Dreamland Garden."

A calendar received from the Siluminite Insulator Co., Ltd., has monthly date slips and a picture of a dog sitting safely on a "Siluminite" live rail cover, although his chain has made contact with a return rail. The picture also shows some of the firm's track insulators.

**South African Electrical Imports.**—Whether the record of 1921, when electrical material and machinery were imported into South Africa to the high value of £1,926,826, will prove to have been eclipsed this year, is not yet certain, but it is at least assured that the total of £1,010,600, registered on this account in 1922, will be left far behind. As it is, the latest available statistics relating to the Union's imports show that oversea purchases in the first seven months of 1923 amounted to £806,634, as compared with only £517,611 in the corresponding period of 1922, and with light and power schemes in hand at Bloemfontein and such smaller centres as Beaufort West, Wellington, Ceres, and Queenstown in the Cape Province, the prospect is certainly more than ordinarily promising. A point which will naturally appeal specially to Rand, Capetown, and other firms not concerned in the ordinary way with the tenders for large items of plant called for by the various municipalities, is that a fair proportion of the trade now being done is in fittings and accessories. For instance, particularly in Capetown and Durban, interest is being shown in electric cooking and heating apparatus, the imports of which this year have been far in excess of those prevailing in 1922, while both from Natal and Johannesburg we are receiving advices of growing sales of electric flat-irons, toasters, fans, and other similar lines. The building boom now apparent throughout the Union, in addition, is having a marked effect on the demand for lamps, shades, wiring, &c., and altogether it may be said that the specific section of the electrical material and machinery trade in which the average merchant is interested is as substantial in volume as it has been for some time past. If, as seems probable, the record of 1921 is beaten in 1923 or 1924, therefore, the merchant will benefit proportionately with the manufacturer of generating and other large plant.—*British and South African Export Gazette.*

**Local Exhibition.**—Southport.—Vigorous opposition was put forward at a meeting of the Town Council, on December 12th, to a proposal for the establishment of an electricity showroom and sales department. Eventually, however, the electrical engineer was authorised to arrange an electrical exhibition and advertising campaign, and to prepare a report for consideration as to the establishment of a showroom and sales department. It was stated that the equipment of the last electrical showroom cost the Corporation £1,500, and the total return was only about £300. It was contended that the proposal was unfair to private electrical contractors. In reply, a member of the Electricity Committee said the exhibition would not cost the Corporation anything. A firm whose business it was to finance and run these exhibitions was prepared to undertake it. The committee was not satisfied with the show of appliances the private electrical contractors were making.

**Radio Exhibition at Geneva.**—The *Board of Trade Journal* states that it is proposed to hold an exhibition of radio-telephony apparatus, &c., at Geneva, probably in May next. The exhibition is intended primarily for Swiss manufacturers, but it is understood that foreign goods will be admitted provided they are represented by local firms.

**Christmas and New Year Holidays.**—The offices of the Jackson Electric Stove Co., Ltd., will be closed from midday on Saturday, 22nd inst., until the morning of Thursday, 27th inst.

The head office and works of the Chloride Electrical Storage Co., Ltd., Clifton Junction, will be closed from noon on December 22nd to December 26th inclusive, and also on January 1st.

The offices of Messrs. Henry Joseph & Co., Ltd., will be closed from Friday, 21st inst., until Thursday, 27th inst.

We are informed by Messrs. Bruce Peebles & Co., Ltd., that their works will be closed for the New Year holidays from December 29th to January 7th inclusive.

**Styrian Water-power Undertaking.**—The Styrian Electricity & Water-power Co., whose projects were referred to in this journal a year or two ago, is now making a further issue of capital. This is to be raised by the company's old financial group and a new Italian group, which will be equally concerned with the management and the flotation of the capital. It is reported from Vienna that contracts for the construction and equipment of the company's works will only be placed abroad if foreigners offer prices which are at least 5 per cent. lower than the inland offers, while the maximum which can be allotted abroad will not exceed 25 per cent. of the value of the contracts.

**Bennis Contracts.**—We have received a lengthy list of orders that have been received recently by Messrs. Ed. Bennis and Co., Ltd., for their "Sprinkler" and "Chain-grate" stokers and self-cleaning compressed-air furnaces. The list includes a second repeat order from the Sheffield Corporation for Neepsend power station; an order from Messrs. Clayton and Shuttleworth, Ltd., for the Yorkshire Electric Power Co. for Thornhill power station, Dewsbury; and other requisitions for collieries, iron and steelworks, and other industrial works, as well as equipment for shipment to Indian, Japan, &c.

Coal- and ash-handling plant orders include: Ash and dust extraction plant for Yallourn power station for the State Electricity Commission of Victoria, Australia; and a repeat contract for an ash hoist for the South Lancashire Tramways Co.'s generating station, Atherton.

**Lead.**—Messrs. James Forster & Co. report, under date December 15th, as follows:—Board of Trade returns for November: Imports, 22,589 tons; exports, 1,645 tons; leaving for home absorption 20,944 tons. For the four months August-November the last figure averages 16,573 tons per month against an average for the whole of last year of about 12,000 tons, a very remarkable increase of roughly 38 per cent., which is likely to be maintained this month, as arrivals, so far, are again on a large scale. If all this metal is going into consumption it indicates a highly prosperous condition in the lead trade, as manufactures, in values, are far and away above anything known in the past history of the trade, at any rate as far as the domestic trade is concerned.

**British Trade-mark Applications.**—The following are among the recent applications for British trade marks. Objections may be entered in respect of any of the proposed marks within one month from the dates mentioned.

Taymar. No. 442,025. Class 13. Electric switches. Arthur B. Taylor, 586, Streatham High Road, London, S.W. December 12th, 1923.

Holderstat. No. 441,911. Class 8. Thermionic valves and valve sockets combined with variable electrical resistances. Radio Communication Co., Ltd., 34-35, Norfolk Street, Strand, London, W.C. December 5th, 1923.

Ensynophon. No. 442,186. Class 8. Apparatus used in telegraphy and wireless telephony. Houghton's, Ltd., Ensign House, 9, High Holborn, London, W.C. December 12th, 1923.

Sterling, London (lettering and design). No. 437,641. Class 6. Electric blasting machine and mine exploders and like dynamo-electric and magneto-electric machines and parts. No. 435,954. All goods in Class 8. The Sterling Telephone and Electric Co., Ltd., 210-212, Tottenham Court Road, London, W.C., December 12th, 1923.

Nomag. No. 439,152. All goods in Class 6. Ferranti, Ltd., Hollinwood, near Manchester. December 12th, 1923.

Orbit. No. 442,394. Class 6. Electric fans. Verity's, Ltd., Plume and Victoria Works, Plume Street, Aston, Birmingham. December 12th, 1923.

The Guarantee of Quality and Efficiency (lettering and design). No. 435,320. Class 8. Telephonic and telegraphic apparatus. The Telephone Manufacturing Co., Ltd., 42a, Martell Road, West Dulwich, London, S.E. December 12th, 1923.

Ultra. No. 439,257. Class 8. Telephones, loud speakers, condensers and transformers. Edward E. Rosen & Co., City House, 158, City Road, London, E.C. December 12th, 1923.

Cefco. No. 440,424. Class 8. Electrical apparatus and instruments, wireless telephonic apparatus and parts, fitted electric switchboards, rheostats, electric condensers, &c. C. E. Falconbridge, Ltd., 2, Goldsmith Street, Nottingham. December 12th, 1923.

**German Industry During November.**—While no direct reference is made to the electrical industry in the monthly report (November) of the Commercial Secretary at Berlin (Mr. J. W. F. Thelwall), in referring to the ceramic industry he states that the electro-technical porcelain branch suffered from a lack of orders and short-time working.

**Electricians' Wages.**—At the meeting of the No. 2 District Council, Electricity Supply Industry (Yorkshire, &c.), on December 12th, the question of the application of the employés at the Hull Corporation electricity works for a general increase of 1d. per hour again came up for consideration. Messrs. Proudler and Leary (employés' side) reported that they had interviewed the men's representatives and that as a result a mass meeting of the employés had passed a resolution to the effect that as the Trade Union side of the District Council was making application for a general increase of wages throughout the area no action would be taken locally which might prejudice this application.

**G.E.C. Activities.**—Among the more recent "jobs" which the General Electric Co., Ltd., has carried out, or for which it has supplied lamps and fittings, are the following: The floodlighting of the façade of the Grands Magasins à l'Innovation, Brussels; the lighting of the new General Post Office, Perth, Western Australia; special decorative lighting for a "command" performance at the Coliseum, London; and the illumination of one of the Liverpool Corporation's tramcars.

**Telephones for Czecho-Slovakia.**—A *Reuter* dispatch from Prague says that the Telegrafia Co., of Prague, in which the Czecho-Slovak Ministry of Posts and Telegraphs holds the controlling interest, has signed a contract with the Relay Automatic Telephone Co., of London, for the manufacture of patents under a licence for ten years. "This is the first time a British electrical business has succeeded in competition with the long-standing German monopoly in Central Europe."

**British Empire Exhibition Note.**—Among the exhibits which are being arranged by the British Electrical Development Association is an electrical device for dispelling smoke in cities.

**Catalogues and Lists.**—Messrs. Reeves & Co., Crescent Works, Birmingham.—An illustrated list of electrical accessories (switches, ceiling plates, lampholders, &c.) and metal stampings for the electrical trade.

The English Electric Co., Ltd., Queen's House, Kingsway, W.C.2.—Publication No. 322, describing in detail, with illustrations, flame-proof motors for use in mines and similar situations.

The General Electric Co., Ltd., Magnet House, Kingsway, W.C.2.—Publication W. 2,912, describing the details of the "Kingsway" wiring system. Fully illustrated and priced. An illustrated folder presenting a number of suggestions for Christmas gifts, including radio apparatus, domestic appliances, &c. Priced. Leaflet O.S. 3,228, advertising colour-sprayed gasfilled lamps in sets of six for all standard voltages.

The Wholesale Fittings Co., Ltd., 23, 25, and 27, Commercial Street, E.1.—An illustrated and priced catalogue of many types of lighting fittings, including pendants, bowls, brackets, statuettes, &c.

Siemens & English Electric Lamp Co., Ltd., 38 and 39, Upper Thames Street, E.C.4.—Catalogue No. 93, containing illustrations, prices, and details of electric fires and cookers.

Messrs. S. G. Leach & Co., Ltd., 26-30, Artillery Lane, E.C.—List L.F. 1, containing illustrated details and prices of electric fans of various types—desk, bracket, oscillating, &c.

Ateliers de Constructions Electriques de Charleroi, 56, Victoria Street, S.W.1.—December stock list of motors and dynamos.

Autoveyors, Ltd., 84, Victoria Street, S.W.1.—A booklet illustrating a number of applications of a variable three-electrode bridge condenser to radio-telephony receiving circuits.

Marconi's Wireless Telegraph Co., Ltd., Marconi House, Strand, W.C.2.—Pamphlet No. 223, presenting full technical data relating to multi-valve amplifying detectors and low-frequency magnifiers.

Messrs. William Sanders & Co., Falcon Electrical Works, Wednesbury.—A well-illustrated and priced catalogue dealing with metal pressings, switch- and fuse-gear of a number of designs, including ironclad switches, teak-cased distribution boards, &c., and cable glands and sockets.

The Sun Electrical Co., Ltd., 118-120, Charing Cross Road, W.C.2.—An illustrated booklet giving details and prices of "Sunlite" reflectors for show-window lighting; also folders advertising the "A.B.C." electric washing machine.

**For Sale.**—Sheffield Corporation Tramways and Motors Committee has for disposal nine traction motors and 12 tramcar controllers. (See our advertisement pages to-day.)

**Another Cable Contract.**—We are pleased to record that Messrs. Siemens Bros. & Co., Ltd., London, have received a contract for a telephone cable, which will be laid during next summer between this country and Holland.

The new submarine cable is now in course of manufacture at Woolwich. It has 16 paper-insulated cores laid as four quads, each core being continuously loaded. There is a double lead sheathing and single-wire armouring. The contract was placed with Messrs. Siemens by the British Post Office on behalf of the Governments interested. A similar cable has been laid in the Baltic, but the Anglo-Dutch cable will be the first in tidal waters.

**New Showrooms.**—On Monday last Messrs. Joseph Springer, Ltd., opened new showrooms and an exhibition at 152-158, Wardour Street, W.1. The firm specialises in supplies of all kinds for the kinema industry, from floor coverings to projectors, and the show is, on this account, very comprehensive. Probably the main feature of the new showrooms is the display of lighting fittings with which the ceiling is covered. There are about 200 examples of these and they are all very beautiful productions. Two chief types, of which there are numerous examples, are mosaic Czecho-Slovakian glassware bowls and lanterns and bowls of Italian marble pieced together in a very artistic manner. Many designs for wall and ceiling decoration appear, all of which are of pressed steel, which looks like plaster when coloured. Another speciality of the firm's is a combined curtain control and light dimming device, by means of which the lighting in a kinema theatre is gradually reduced to zero as the curtain covering the screen is drawn aside. Projectors are also shown and one feature shown in connection with these is a remotely-controlled step-by-step device for controlling the arc from the machine.

**An X-ray Exposure Table.**—Messrs. Watson & Sons (Electro-Medical), Ltd., are distriutbing to *bond-fide* applicants a useful little card upon which is a table of times of exposure for Coolidge X-ray tubes arranged for three current strengths and for various parts of the human body.

**Copper and Lead Prices.**—Messrs. F. Smith & Co. report December 18th:—No change in price for electrolytic copper.

Messrs. James & Shakespeare report December 18th:—Copper bars (best selected), sheet and rod, no change; English pig lead, £32 15s., 5s. increase.

**"Electric Avenue."**—The announcement in the newspaper Press of the sale of a block of the Fyfe estate, including a number of premises known as "Electric Avenue" and "Electric Mansions," Brixton, will recall to some of the more mature members of the electrical profession the days when the electrical installation which supplied the energy for the blaze of illumination of that avenue and property was a conspicuous demonstration of electrical work and possibilities.

## LIGHTING AND POWER NOTES.

**Ashford (Kent).**—Proposed Electricity Supply.—The Urban District Council has appointed an Electricity Committee for the purpose of considering the question of a supply of electricity for the town.

**Ashton-under-Lyne.**—Extension of Supply.—The Town Council proposes to extend its electricity supply to the Hurst and Limehurst districts. Sanction has been received to the borrowing of £103,000, of which £84,000 will be expended on plant, £7,600 on a cooling tower, £7,000 on mains, and £4,000 on transformers.

**Atherton.**—Commissioners' Inquiry.—The Electricity Commissioners have held an inquiry into the application of the South Lancashire Tramways Co. for sanction to extend the plant at the generating station, in order to meet the increased demand for power. It was stated that the company had, since 1902, supplied the U.D.C. at a lower rate than any other town in Lancashire. The lighting rate is 4½d. for the first 600 kWh and 3½d. for the next 600 kWh.

**Bakewell.**—Electricity in Bulk.—The Urban District Council is negotiating with the Derbyshire and Nottinghamshire Electric Power Supply Co. with a view to obtaining a bulk supply of electricity for the district.

**Boston.**—Street Lighting.—The Paving and Lighting Committee considers it desirable that all the main streets of the borough should be lighted by electricity, and has recommended that the Boston and District Electric Supply Co., Ltd., be asked to lay the necessary cables.

**Bradford.**—New Plant.—The Corporation has recently closed down the last slow-speed generating set, and opened a new boiler house at Valley Road power station. The former was installed in 1905, and is being removed to make room for a new 16,000-20,000-kW, 3,000 r.p.m. turbo-generator. The new boiler house contains four marine-type boilers, coal-conveying plant, and other auxiliary equipment, the total amount of the contract being £240,403. The contractors are Messrs. Babcock & Wilcox, Ltd., and the new works were upon the designs and specifications of Mr. Thomas Roles, the city electrical engineer.

**Bury (Lancs.).**—Loan.—The Town Council has applied to the Electricity Commissioners for sanction to the borrowing of £2,200 for laying cables to the Heywood boundary.

**Clacton.**—Loan.—Application is being made to the Electricity Commissioners for sanction to borrow £4,303 for mains.

**Continental.**—Sweden.—According to the *Svenska Dagblad*, the Swedish Waterfall Board estimates the surplus which it will be able to hand over to the Treasury during 1924 at 10,000,000 kr., of which 9,580,000 kr. is in respect of the State power stations, 350,000 kr. on account of the State canals and waterways, and 70,000 kr. from the Real Estate Department. The surplus income from the State power stations is distributed as follows: Trollhätte power station, 4,390,000 kr.; Motala power station, 1,015,000 kr.; Västerås power station, including the Western trunk line, 650,000 kr.; Porjus power station, 900,000 kr.; and other power stations 30,000 kr. The working expenses of the State Waterfall Board for 1924 are estimated at 9,000,000 kr., as compared with 8,760,000 kr. for 1923. The Board estimates the surplus revenue for 1923 at 8,300,000 kr., the surplus for 1924 being calculated to show an increase of 1,700,000 kr.—*Board of Trade Journal.*

**Crook.**—Loans Sanctioned.—The Urban District Council has received the sanction of the Electricity Commissioners to the borrowing of £9,400 in connection with the electricity scheme and sanction from the Ministry of Health to a loan of £1,228 for street lighting.

**Elgin.**—New Plant.—The Elgin Electric Supply Co. has recently installed a second generating set at its electricity works. The new plant consists of one 120-h.p. two-cylinder vertical Ruston-Hornsby crude oil engine, direct coupled to a Mather and Platt dynamo, with an output of approximately 60 kW.

**Eston (Yorks.).**—YEAR'S WORKING.—The accounts of the Urban District Council's electricity undertaking for the year ended March 31st last show a total revenue of £2,235. Working expenses amounted to £1,927, leaving a gross profit of £308. Capital charges absorbed £454, and there was a net deficit for the year of £146.

**Exeter.**—SPECIAL ORDER.—The Corporation has applied to the Electricity Commissioners for a Special Order authorising it to extend its area of electricity supply so as to include certain parishes in the Rural District of St. Thomas.

**Glasgow.**—PROPOSED NEW PLANT.—A Sub-committee of the Corporation Tramways Committee has recommended that a new 10,000-kW set be installed at Pinkston power station.

**Grange-over-Sands.**—ELECTRICITY SUPPLY.—Owing to a dispute having arisen between the Urban District Council and Messrs. T. Wilkinson (Arnside), Ltd., the company has given notice to terminate the electricity supply agreement next year. The Council has approached the Barrow Corporation with a view to obtaining a bulk supply. The Barrow Corporation has authorised the sub-committee conducting the supply to Ulverston and Dalton to negotiate with the Grange Council.

**Hemsworth.**—ELECTRICITY ORDER.—The Rural District Council is applying to the Electricity Commissioners for a Special Order authorising it to supply electricity within the district.

**Hitchin.**—SPECIAL ORDER.—The Electricity Commissioners have submitted to the Ministry of Transport for confirmation a Special Order made by them authorising the Electric Supply Corporation, Ltd., to supply electricity in the district.

**Ilford.**—LOAN.—The Urban District Council has applied to the Electricity Commissioners for sanction to the borrowing of £2,000 for wiring houses on the rental system.

**Irish Free State.**—CLONMEL (CO. TIPPERARY).—The Corporation has received a report from Messrs. Turney, electrical engineers, Dublin, on a proposed electricity scheme for the town. The company proposes two schemes, costing from £14,000 to £19,000. The report has been referred to the Lighting Committee for consideration.

DUNDALK.—In connection with the recent extension of the municipal electricity works, the Urban District Council is applying for sanction to a further loan of £2,000. A recommendation by the engineer for a reduction to 2½d. per kWh during winter months and to 2d. per kWh in summer in the charge of electricity cooking and heating has been adopted.

**Leicester.**—NEW PLANT.—The Corporation is proceeding with the second part of the scheme for extending the electricity works, and has decided to install four Spearing water-tube boilers.

**Malvern.**—LOAN.—The Urban District Council has applied to the Electricity Commissioners for sanction to a loan of £1,700 for a new boiler and superheater, &c., for the electricity works. The Council hopes to obtain a bulk supply of electricity from Worcester by the end of January.

**Marlborough.**—SPECIAL ORDER.—Application has been made to the Electricity Commissioners by the Corporation for a Special Order authorising it to supply electricity in the borough.

**New Zealand.**—POWER DEVELOPMENT.—The report for 1922-23 of the Public Works Department shows that the total installed plant capacity at March 31st last was 57,589 kW, an increase of about 11 per cent. during the year. This capacity was fairly evenly divided between fuel and water-power stations, the latter being shown as 28,203 kW. It is not anticipated that the fuel stations will be extended to any great extent, but the plans for hydro-electric development aim at the production of 182,000 kW by this means. by 1930.

**Northern Ireland.**—BALLYBAY (CO. MONAGHAN).—The Rural District Council is to withdraw its application to hte Ministry of Industry and Commerce for sanction to supply electricity in the town. The ratepayers object to the scheme on the grounds of the existing high rates.

WARRENPOINT (CO. DOWN).—The Urban District Council has requested Messrs. Chapman & Chapman, electrical engineers, Belfast, to submit a scheme for street lighting by electricity.

**Price Reductions.**—Reductions in the charges for electricity have been made in the following districts:—

WINCHESTER.—Power: From 5½d., 2½d., and 1½d. per kWh to 4d. 2d., and 1d. per kWh.

STEPNEY.—Upon the recommendation of the electrical engineer, it is proposed to reduce the charges for energy sold under Scales A and C after 30 hours' use of the maximum demand from 2d. and 1d. to 1½d. and ¾d. respectively.

DARLINGTON.—Lighting: 2d. per kWh for all energy used during the summer quarters, and 2d. per kWh for an equal number of kWh used during the winter quarters, and 3½d. per kWh for all additional energy used in winter. Cooking and heating: ¾d. per kWh for all kWh used in summer and for an equal amount of energy in winter, and 1½d. per kWh for all additional energy used during the winter quarters. Power: First 500 kWh per quarter, 1½d. per kWh; next 500, 1½d. per kWh; next 2,000, 1d. per kWh; for all energy above this amount ¾d. per kWh. Maximum demand rate: £3 per kW and ¼d. per kWh. Traction: ¾d. per kWh.

MERTHYR TYDFIL.—Lighting: 8½d. per kWh for first 40 kWh per quarter, next 50, 8d. per kWh, and 7½d. per kWh beyond.

**Sandwich.**—ELECTRICITY SUPPLY.—The Town Council has decided to object to the East Kent Electricity Order, as arrangements have been made to obtain a supply of electricity from Stonar power station.

**Sheffield.**—MAINS EXTENSIONS.—The Electricity Committee has approved the following schemes with a view to providing work for the unemployed: E.h.p. feeder cable from Fulwood to Millhomes, at a cost of £13,545; mains extensions, £2,099; and other extensions and works, at an estimated cost of £2,263.

**South Africa.**—POWER-STATION AGREEMENT.—According to the *African World*, the Electricity Commission has approved the erection of the Witbank power station by the Victoria Falls and Transvaal Power Co., Ltd., on the lines of the heads of agreement between the parties; any vital amendments are to be referred to the Commission.

**Stockton.**—MAINS EXTENSIONS.—The Electricity Committee has had before it a report showing the cost of cable extensions to Norton Grange estate, Roby Road, and Durham Road to be £14,321, as compared with the estimate of £17,206, and has decided to apply to the Electricity Commissioners for sanction to a loan to cover expenditure, together with an additional sum of £664 for extending the cable to Norton Junction Road. The Electricty Commissioners have asked for a report regarding the proposed Hartburn and district supply.

**Wimbledon.**—LOAN.—The Corporation is applying to the Elctricity Commissioners for sanction to the borrowing of £5,000 for domestic appliances to be let out on hire.

**Wivenhoe (Essex).**—ELECTRICITY SUPPLY.—The Urban District Council, after considering the proposed purchase of the local electricity undertaking, has decided to ascertain if it is possible to obtain a supply of electricity from outside sources, and thus avoid heavy expenditure.

## TRAMWAY AND RAILWAY NOTES.

**Continental.**—RUSSIA.—The *Ost Express* states that the Berlin Soviet Trade Mission is at present negotiating with a group of French and Czecho-Slovak firm sregarding the construction of an underground railway in Moscow. The experts have taken as a basis the plans drawn up before the war, and estimate the time required for the construction at from four to five years. The cost will be 120,000,000 gold roubles and payment will be spread over 30 years. The Moscow municipality which will have the sole right of exploitation, hopes to carry out the scheme without State aid.—*Reuter's Trade Service* (Berlin).

SWITZERLAND.—The Swiss Federal Council is seeking powers to enable it to grant a concession for the construction of an electric funicular railway in Canton Valais from Orsières to Champex.—*Modern Transport*.

**Darlington.**—PROPOSED EXTENSIONS.—The Electricity and Light Railways Committee is to hold a special meeting in January to consider a report submitted by the manager on the question of tramway extensions.

**Heywood.**—INCREASED TRAM FARES.—At a meeting of the Town Council, on December 12th, it was decided to increase the minimum tram fare to 1½d. The chairman of the Electricity and Tramways Committee pointed out that the increase was necessary to avoid further serious losses.

**London.**—CHRISTMAS TRAMWAY SERVICE.—The London County Council has announced that all tramcars will be in the depôts by 4 p.m. on Christmas Day. Notices are to be exhibited giving the times of last cars from terminal points, etc.

**Manchester.**—NEW ROUTE.—The Tramways Committee has under consideration a proposal to extend the tramway track from Brook's Bar along Chorlton Road to Stretford Road.

**Oldham.**—RAILLESS CARS.—At a recent meeting of the Town Council it was decided to apply for Parliamentary powers to run railless cars along Ashton Road, King Street, and Chaucer Street.

**Sheffield.**—UNEMPLOYMENT RELIEF SCHEME.—With a view to providing work for the unemployed the Corporation is to construct 25 new tramcars, at an estimated cost of £54,375.

**Scarborough.**—RESUMPTION OF SERVICE.—The tramway service, which was suspended some time ago on account of the liquidation of the company, was resumed on December 10th.

## TELEGRAPH & TELEPHONE NOTES

**Austria.**—Strike.—The strike of post office, telegraph, and telephone employés in the Vienna services, which began on December 10th as a result of the Austrian Government's refusal to grant an increase of wages, came to an end on the 13th inst., negotiations having been resumed the day before.—*The Times.*

**China.**—Radio Stations.—The Radio Corporation of America, through its affiliated organisation, the Federal Telegraph Co. of California, is perfecting plans for a group of radio stations in China, to cost $13,000,000 and to be completed in 24 months. The central plant in Shanghai will be of 1,000-kW capacity, with seven steel towers, each 1,000 ft. high. Other stations will be at Pekin, Canton, and Habin. Mr. R. P. Schwerin, president of the Federal Company, will be in charge.—*Electrical World.*

**Germany.**—New Radio Transmitter.—A new German machine for the transmission of radio messages in cipher was tested on December 11th. Telegrams exchanged between Dr. Höfle, the German Minister of Posts, and the Swiss Postal Administration at Berne were correctly decoded. It is claimed that no unauthorised receiver can decipher messages dispatched by the new machine. There is no loss of time in transmission.—*The Times.*

**Italy.**—Radio Telegraph Patents.—Senator Marconi states that the reported declaration by the Postmaster-General to the Italian Senate that the Italoradio Co., the concessionary for radio telegraphy in Italy, has the use of all French, British, and German patents for the Italian services cannot apply to the Marconi Co.'s Italian and foreign patents. A further denial is given to the statement that the Italoradio Co. is participating in a world radio trust, for this has not so far been constituted. The Italoradio, however, is associated with the German Telefunken Co. and the French Société Télégraphie sans Fil.—*Financial Times.*

**Transatlantic Radio.** — Low-power Communication.—Amateurs established the first short-wave two-way communication between England and the United States on the morning of December 3rd, when Mr. Kenneth Warner, secretary of the American Radio Relay League, operating the amateur station, 1 MO, at Hartford, exchanged messages with the South-West London station 2 KF, operated by Mr. J. A. Partridge. Reliable contact was maintained for more than two hours on a 100-metre wave-length.—*Reuter.*

The English "1,500-volt transmitter had an input of 100 watts and an aerial current of 1.8 amp." Two 50-ft. steel masts, 50 ft. apart, supported a 3-wire aerial, and the American operator used an aerial current of 2.5 amps. with an input of 400 watts. The Morse "talk" was heard on 3-valve receivers, and lasted from 5.50 to 8 a.m. G.m.t., after which time the signals grew weak.—*Daily Mail.*

## RADIO NOTES.

**Radio-Broadcasting.**—Wave Lengths.—A second change was made on December 14th in some of the wave lengths used by the B.B.C. stations; that of London is now 365 metres, instead of 350; that of Newcastle-on-Tyne 435, instead of 370; and that of Cardiff 350, instead of 435.

**United States.**—Broadcasting Statistics.—Messrs. P. C. Kullman & Co., of New York, are issuing the fifth of a series of circulars designed to create a world-wide interest in radio telephony. Officers in charge of radio-telegraphy and telephony in America and 112 foreign countries have been circularised with interesting statistics, including the following:—The WGY station authorities have received over 2,000 letters in a single week referring to one programme; the radio-telephone industry provides employment for a million persons in America; the audience in the U.S.A. consists of five million persons; and the number of stations is: Transoceanic 12, experimental 292, broadcasting 591, point-to-point commercial 128, limited point-to-point public 40, general public service 41, aeroplane 2, technical training school 128, estimated ships 3,000, amateur (licensed) 18,357, receiving (unlicensed) estimated 3,500,000.—*T. & T. Age.*

## CONTRACTS OPEN AND CLOSED.

*(The date given in parentheses at the end of the paragraph indicates the issue of the* Electrical Review *in which the "Official Notice" appeared in our advertisement pages.)*

### OPEN.

**Aylesbury.**—Electricity Department. One 30-ft. portable coal conveyer driven by a 220-V d.c. motor. (See this issue.)

**Aldershot.**—January 1st. Electricity Department. 550 yd. 4-core, paper-insulated armoured cable. (December 7th.)

**Argentina.**—Buenos Aires.—January 21st. Department of Sanitary Works. Steam-driven electrical generating plant, for the waterworks at Posadas.*

**Australia.**—Sydney.—February 25th. Municipal Council. The Department of Overseas Trade states that the date for receipt of tenders for the supply of step-down transformers and induction regulators has been altered from January 14th to February 25th, and that amended specifications have been issued.*

Melbourne.—February 11th. Electricity Commission. Four 100-kVA, 25,000-6,000-V transformers and spares. (See this issue.)

**Barking.**—January 10th. County of London Electric Supply Co., Ltd. Complete lighting installation for the Barking power station and site. (See this issue.)

**Belfast.**—The Board of Guardians has extended the time for the proposals for central heating and lighting schemes until March 18th, 1924.

**Belgium.**—January 11th. Municipal authorities of Petit Spauwen (Province of Limbourg). Establishment of a low-pressure electricity system to serve the little towns of Heers, Vlyttingen, Veldwezelt, Gellick, and Moppertingen. Particulars for 40 fr.

**Canada.**—Toronto.—January 15th. Mayor and Board of Control. Centrifugal sludge pump, with induction motor.*

January 15th. Electrically-driven air compressor, with accessories, and one separator.*

**Cardiff.**—January 14th. Electricity Department. One 40,000-lb. water-tube boiler. (December 14th.)

**Dublin.**—January 1st. Port and Docks Committee. Two pairs of steel tramway-type rail switches. Particulars from engineer's office, East Wall.

**Eastbourne.**—January 1st. Electricity Department. H. and l.p. paper-insulated cable. (December 7th.)

**Egypt.**—Cairo.—January 21st. Ports and Lights Administration. Stores, including electrical goods, &c.*

**Gravesend.**—December 31st. Town Council. Wiring houses, &c., under assisted wiring scheme. Borough electrical engineer, Suffolk Road.

**India.**—India Store Department.—January 14th. Turbo-alternator set, condensing plant, cranes, boiler, economiser, pumps, steel chimney, pipework, switchboard, motor converter set, rotary converters, sub-station plant, e.h.p. feeder cables, and auxiliaries for new power station and sub-station at Delhi. (December 14th.)

**London.**—Islington.—January 17th. Electric Supply Department. One 5,000-kW, two-phase turbo-alternator, condensing plant, piping, &c. (December 7th.)

**Manchester.**—January 8th. Electricity Committee. One 2,500-kW motor-converter (lighting and power service), six 1,050/1,270-kW motor-converters (lighting, power and traction services). (See this issue.)

**New Zealand.**—January 30th. Taranaki Electric Power Board. Generators and switchgear.*

Touranga.—February 19th. Town Council. McLaren Falls development scheme (contracts for sections 15 to 18). (December 14th.)

Wellington.—May 23rd (extended from April 30th). Public Works Tender Board. Arapuni electric power scheme (section 2, power house and plant). Design, manufacture, supply, erection, testing, and maintenance for a period of six months of hydro-electric power station at Arapuni on the Waikato River, including machinery and plant, outdoor step-up transformer station, buildings, and all accessories.*

**South Africa.**—Johannesburg.—January 21st. Municipal Council. 240 tram poles, five miles of h.d. copper trolley wire.*

**Spain.**—Madrid.—February 6th. Supply of electric locomotives for the Ripoll-Ax-les-Thermes railway. This is the second competition, the first not having produced any result. Particulars from the Excmo. Señor Director de Obras Públicas, Ministerio de Fomento, Madrid.—*Reuter's Trade Service* (Madrid).

**Stoke-on-Trent.**—January 16th. Electricity Department. One 50-ton electrically-driven overhead travelling crane. (See this issue.)

**York.**—January 16th. Electricity Department. Two 25,000-lb. water-tube boilers, economisers, steam pipes, feed pumps, &c. (See this issue.)

*Further particulars can be obtained at the Department of Overseas Trade (Inquiry Room), 35, Old Queen Street, S.W.1.

### CLOSED.

**Belgium.**—There was keen international competition for the recent contract of the municipal authorities of Ghent for the supply of eight electric cranes for the docks in that town, no less than eight Belgian, one Czecho-Slovakian, one French, and two Dutch concerns submitting tenders for the work. The lowest offer was that of a Belgian firm, the Société des Usines Ragheno, of Malines.

**Glasgow.**—Tramways Committee. Recommended:—
Lead-covered cable.—Western Electric Co., Ltd.
Cadmium trolley wire.—R. Johnson & Nephew, Ltd.
D.c.c. wire.—British Insulated & Helsby Cables, Ltd.
Steam valves for subway.—Cockburn, Ltd.
Stores—C.i. brake blocks.—Miller & Co., Ltd.
Rubber and asbestos.—North British Rubber Co., Ltd.

**Tramway Rail Contract.**—With further reference to our note on p. 901 of our last issue, the Town Council, after consideration, has decided to accept the tender of Messrs. Hadfields, Ltd., at £9,794. The matter is referred to in our "leader" pages to-day.

**London.**—LONDON COUNTY COUNCIL.—Highways Committee. Supply of about 3,400 tons of track rails and fastenings during a period of six months, and, alternatively, for the supply of about 5,100 tons during a period of 12 months:—

| | For 3,400 tons. | For 5,100 tons. |
|---|---|---|
| **Bolckow, Vaughan & Co., Ltd.** ... | £37,805 | **£57,080** (Accepted.) |
| Cargo Fleet Iron Co., Ltd. ... ... | 38,282 | 57,801 |
| Dorman, Long & Co., Ltd. ... ... | 38,540 | 58,850 |

The chief engineer's estimates comparable with the tenders were £39,963 and £61,017 respectively. All the tenders are for rails of British manufacture.

Ventilating fans, motors, &c., in connection with the ventilation installation at Rotherhithe Tunnel:—

| | |
|---|---|
| **J. Keith & Blackman Co., Ltd.** (Accepted.) ... ... | **£1,600** |
| Davidson & Co., Ltd. ... ... ... ... ... ... ... | 2,239 |
| Ditto (alternative) ... ... ... ... | 1,734 |
| Sturtevant Engineering Co., Ltd. ... ... ... ... ... | 2,266 |
| Ditto (alternative) ... ... ... ... | 2,098 |

Chief engineer's estimate, £1,840.

Additional coal bunkers at Greenwich power station:—

| | Original tender. | Amended tender. |
|---|---|---|
| K. Holst & Co. ... ... ... ... ... | £27,915 | £31,830 |
| J. Mowlem & Co., Ltd. ... ... ... | 29,238 | — |
| Ditto ... ... ... ... | 29,792 | — |
| Ditto ... ... ... ... | 37,192 | — |
| Ditto ... ... ... ... | 37,671 | 42,621 |
| Peter Lind & Co. ... ... ... ... | 29,800 | 30,500 |
| **Industrial Constructions, Ltd.** ... ... | 32,015 | 33,368 |
| Ditto (Alternative) ... | 32,859 | **34,243** (Accepted.) |
| Christiani & Nielsen ... ... ... ... | 38,475 | — |
| Anglo-Danish Concrete Construction Co., Ltd. ... ... ... ... ... | 40,650 | — |
| D. G. Somerville & Co., Ltd. ... ... | 44,500 | — |
| Baldry, Yerburgh & Hutchinson, Ltd. ... | 46,130 | — |
| Ditto ... ... ... ... | 44,630 | — |
| Holloway Bros. (London), Ltd. ... ... | 47,400 | — |
| The Yorkshire Hennebique Contracting Co., Ltd. ... ... ... ... ... | 56,000 | — |
| A. Jackaman & Son, Ltd. ... ... ... | 56,790 | — |
| Holliday & Greenwood, Ltd. ... ... ... | 60,735 | — |
| The Foundation Co., Ltd. ... ... ... | Actual cost, plus 10 per cent., together with 2½ per cent. a month on purchase value of contractors' heavy plant. | |

Certain of the tenderers were communicated with in order to ascertain more fully the details of their schemes, and as a result it was found that full compliance with the Council's requirements and contract conditions necessitated modifications in the constructional designs, and consequential alterations in the amounts of the tenders affected. From a careful examination of the tenders as thus amended, it appeared that the lowest satisfactory scheme, having regard to the structural requirements, was that covered by one of the alternative offers, submitted by Industrial Constructions, Ltd., amounting to £34,243, plus £633, owing to the rise in steel since the original tender was submitted.

After careful consideration the Committee has come to the conclusion that the Council's interests will best be served by accepting this tender.

METROPOLITAN ASYLUMS BOARD.—Alterations and extensions to electric lighting and power installations in kitchen at Tooting Bec Mental Hospital:—

| | |
|---|---|
| **Guild of Engineers (London), Ltd.** (Accepted.) ... ... | **£153** |
| Myall Bros. ... ... ... ... ... ... ... ... | 228 |
| Guild Housing, Ltd. ... ... ... ... ... ... ... | 235 |
| C. A. Carpenter ... ... ... ... ... ... ... | 238 |
| Tredegars (1923), Ltd. ... ... ... ... ... ... ... | 242 |
| Manley & Regulus, Ltd. ... ... ... ... ... ... ... | 263 |
| T. Clarke & Co., Ltd. ... ... ... ... ... ... ... | 270 |
| S. Reed & Sons ... ... ... ... ... ... ... | 285 |
| G. Morrison ... ... ... ... ... ... ... ... | 417 |
| A. Higginbotham & Sons ... ... ... ... ... ... | 420 |

New X-ray apparatus for Queen Mary's Hospital for Children (£285).—Newton & Wright. (Accepted.)

ST. PANCRAS.—Electricity and Public Lighting Committee.
Portable oil-purifying installation (£352).—De Laval, Chadburn & Co., Ltd. (Accepted.)

Coal for the Electricity Department. Accepted tenders:—
300 tons Ramcroft 1¼-in. nutty slack (24s. 9d. per ton); 300 tons Newdigate 1¼-in. nutty slack (22s. 11d. per ton); 500 tons Clipston nutty slack (22s. 11d. per ton); 100 tons Newdigate Coleorton d.s. nuts (31s. 5d. per ton).—J. H. Beattie & Co., Ltd.
100 tons House Wharf, small (24s. per ton).—J. L. Davies & Co.
Apparatus for the treatment of circulating water for the condensers at King's Road power station (£295).—Patterson Engineering Co., Ltd. (Recommended.)

STEPNEY.—Electricity Supply Committee.
One works power circuit board (£151).—B. Thomas. (Accepted.)
50 tons pitch (£344).—Forbes, Abbott & Lennard, Ltd. (Accepted.)

PLAISTOW.—Electric clocks on the Synchronome Co.'s system are being installed at St. Mary's Hospital for Women and Children, Plaistow.

**Portsmouth.**—Board of Guardians. Accepted:—
Electrical fittings.—Mr. H. A. Evans.

## FORTHCOMING EVENTS.

**Greenock Association of Electrical Engineers.**—Wednesday, December 26th. At 22, West Stewart Street. At 7.45 p.m. Smoking concert.

**Salford Technical and Engineering Association.**—Wednesday, December 26th. At the Royal Technical College. At 6.15 p.m. Annual social.

**Royal Institution of Great Britain.**—CHRISTMAS LECTURES.—At 21, Albemarle Street, W.1. By Sir William Bragg, F.R.S., on "Concerning the Nature of Things." At 3 p.m. Lecture 1. Thursday, December 27th, on "The Atoms of which Things are Made." Lecture 2. Saturday, December 29, on "The Nature of Gases."

## THE "ELECTRICAL REVIEW" SERVICE DEPARTMENT.

Requests for information must be accompanied by a stamped addressed envelope.

We should be glad to learn the names of makers or suppliers of:—

RADIOLECTRIC fires.

## NOTES.

**The Electrical Engineers' Ball, 1924.**—The fifteenth annual Electrical Engineers' Ball will be held on February 22nd, 1924, at the Hotel Cecil. The event is looked forward to with increasing interest. Last year the number in attendance constituted a record—530 being present. We are pleased to learn that the arrangements which have been completed with the Hotel Cecil are even better than those which gave such great satisfaction on the last occasion. For the information of those interested we give, as usual, a full list of the members of the general and executive committees:—

*General Committee.*

Addenbrook, G. L.
Alabaster, H.
Andrews, Leonard
Atkinson, L. B.
Baldwin, O. H.
Balfour, George, M.P.
Bowden, J. H.
Byng, E. G.
Callender, Sir T. O., J.P.
Chattock, R. A.
Cramb, A. C.
Cridge, A. J.
Couzens, H. W.
Devonshire, Sir James L., K.B.E.
Elder, T. C.
Fairman, H. W.
Ferranti, Dr. S. Z. de
Fox, E. J.
Gatehouse, E. A.
Geipel, Kenneth
Gill, Frank
Gillespie, M. M.
Gray, James
Gregory, J. P.
Gridley, Sir Arnold, K.B.E.
Hadley, A. E.
Highfield, J. S.
Hill, C. W.
Hirst, Hugo
Hunter, P. V., C.B.E.
Hughman, R. W.
Kemnal, Sir James, K.B.E.
Kerr, Douglas
Kingsbury, J. E.
Leaf, H. M.
Leigh, Lt.-Col. F. A. Cortez
Lonsdale, W. Stanley
McGregor, J. J., C.B.E.
McKinstry, A. E.
McKay, H. T. S.
McMahon, P. V.
Matthews, W. Lee
Mordey, W. M.
Moss, E. W.
Nalder, F. H.
Nash, Sir Philip, K.C.M.G., C.B.
New, E. S.
Noble, Sir Wm.
O'Brien, Col. H. E., D.S.O.
O'Meara, Col. W. A. J.
Partridge, G. W.
Petersen, T.
Pooley, F.
Purves, Col. T. F.
Pybus, P. J., C.B.E.
Railing, M. J.
Robinson, L. L.
Rogers, F. M.
Rowell, P. F.
Rutherford, W.
Sayer, C. E.
Scholey, H., C.B.E.
Siddeley, H. C.
Sillar, A. M.
Snell, Sir John
Sparks, C. P., C.B.E.
Sutton, Sir George, Bt.
Taite, C. D.
Taylor, Capt. G.
Taylor, James, J.P.
Wallis-Jones, Capt. R. J.
Walton, A. H.
Wilson, David
Wordingham, C. H., C.B.E.

*Executive Committee.*—O. H. Baldwin, J. E. Kingsbury, W. S. Lonsdale, P. V. McMahon, A. M. Sillar, C. H. Wordingham, C.B.E., R. J. Wallis-Jones, A. H. Walton.
*Hon. Secretaries.*—A. M. Sillar, W. S. Lonsdale.
*Hon. Treasurer.*—J. E. Kingsbury.

**Fatality.**—On December 14th Thomas Yapp, an employé at a Neath tinplate decorating works, was killed by coming into contact with an electric cable carrying current at a high voltage.

**E.P.E.A. Dinner.**—Mr. O. S. Hosgood presided at the recent annual dinner of the Electrical Power Engineers' Association (South Wales section), at the Queen's Hotel, Cardiff. Among those present were Mr. W. J. Oswald (president of the Association), Mr. A. J. Ostler, Mr. W. E. Robertson (chairman of the Newport Corporation Electricity Committee), Mr. C. G. Morley New (city electrical engineer, Cardiff), Mr. A. Nicholls Moore (borough electrical engineer, Newport), and Mr. C. T. Allan (chairman of the Western Centre of the I.E.E.). Proposing the toast of "The Electrical Power Engineers' Association," Councillor W. E. Robertson spoke of the important part played by that organisation, not only in catering for the welfare of its members, but also in the sphere of social service, and Mr. W. J. Oswald, in responding, dwelt upon the importance of electrical power supply as a key industry of the country. The Association had so far devoted most of its energies to the improvement of the status of the profession, stabilising salaries and conditions of working, but the great work before it was that of making the industry of the greatest possible benefit to the whole of the community.

**Periodic Trigger Reception.**—At a recent meeting of the Wireless Section of the Institution of Electrical Engineers, Messrs. E. V. Appleton, M.A., D.Sc., and F. S. Thomson, B.A. (Royal Corps of Signals), discussed the phenomenon of oscillation hysteresis exhibited by simple triode generators, and described a method of reception in which it is utilised in a periodic manner, which is suitable for continuous-wave and spark signals. A low-frequency electromotive force is introduced in the grid circuit of a simple triode oscillator in such a way that high-frequency oscillations are not produced in the absence of an incoming signal. A small signal of high frequency is, however, sufficient to produce a train of free oscillations once every low-frequency cycle. Such free oscillations are rectified by the triode, and a signal of the impressed low frequency is heard in the receiver telephones. The system differs fundamentally from the Armstrong super-regenerative receiver in the following respects:—

(*a*) The ordinary oscillation-hysteresis characteristic is followed "adiabatically"; (*b*) no self-oscillations are produced in the system in the absence of an incoming signal; and (*c*) the amplitude of the telephone signal is practically independent of the amplitude of the incoming signal and not proportional to it as in super-regenerative receivers.

It has been discovered that oscillations may be maintained in a simple triode generator with extreme negative grid potentials, such as would cut off the anode current entirely under normal conditions. A simple theory for the conditions necessary for such maintenance is given. An oscillator of this type is very efficient in that anode and grid currents are only permitted to flow for a very small part of the cycle.

**Electricity at a Gold Mine.**—At the Dome Gold Mine, Northern Ontario, as much of the work as possible is done electrically. A description of the plant was recently published by the *Electrical News* (Toronto). The first stage in getting out ore occurs underground, where the newly broken-up rock is drawn from the chutes by electric locomotives. These dump into loading pockets, from which are filled skips that are hoisted up the shaft and dumped into the ore bins in the head frame. The next stage is the crushing, and the ore travels to the surface crushers from the shaft head in a 25-ton cable car, and is reduced to fairly small size. A belt conveyor carries the crushed pieces to the mill, where the ore begins its devious course through stamps or ball mills, tube mills, &c.

The power factor of the plant is from 80 to 82. Underground there are two 75-h.p. motors, which drive one crusher; one 125-h.p. motor driving a crusher; two 75-h.p. motors driving pumps; five storage battery locomotives and various apparatus in connection with the signalling system. Altogether there are 143 motors, aggregating about 4,000 h.p.

**Modern Illumination.**—Members of the British Association of Display Men visited the demonstration rooms of the Lighting Service Department of the British Thomson-Houston Co. on November 22nd to hear Mr. W. Millner, B.Sc., A.M.I.E.E., lecture upon lighting effects as applied to shop windows, with the aid of a model shop window specially designed to demonstrate lighting effects, and dressed by Messrs. Lyons & Co. He demonstrated the use of reflectors fitted with colour screens, the lamps in the reflectors being manipulated by rotary dimmers. Three colours were used (red, green, and blue), and one dimmer was connected to each circuit and colour. Each dimmer was controlled at a different speed, thus producing a multitude of colour mixtures, the changing tints of which were of infinite variety.

The greatest enemy of display men—daylight reflection in shop windows—he pointed out, was hardly possible to overcome entirely, but it could be accomplished to a certain extent by fitting inclined windows in the shop front so that the dark pavement was reflected on the glass instead of the sky or a building opposite, or by means of floodlight projectors fitted in such a manner that a beam of light was thrown upon the chief object of the display and caused it to stand out and be clearly visible from the street.

A discussion upon this subject then ensued, Mr. Millner suggesting that to obtain the best results from both the display and lighting points of view, it appeared to be necessary for the illuminating engineer and the display man to co-operate. At the conclusion of the lecture Mr. E. Wilson, president of the Association, thanked Mr. Millner for his instructive lecture. He welcomed the suggestion to co-operate, and said that he would bring the matter up at their next committee meeting.

Members of the Junior Institution of Engineers visited the B.T.-H. demonstration rooms on Friday evening, December 7th, 1923, to hear a lecture and witness demonstrations of industrial shop lighting effects. Mr. Millner, by means of lantern slides, charts dealing with the acuity of vision, speed of discrimination, sustained vision, and speed of accommodation, which pointed to the fact that ability to see was considerably increased under high intensities of illumination. A discussion took place between the members upon the lighting of offices and industrial interiors, the lighting of drawing offices being discussed at some length.

**The Electrical Industry's Place in the Chorus.**—Somewhere between the two extremes of Brewster with a million to spend in a year and the poor widow who does house cleaning to support a family, there are thousands of homes where the annual income necessitates a tax return. There are well over 7,000,000 families in the United States reporting an income in excess of $2,000. These are families that live in electrically-wired homes, drive automobiles, enjoy piano and Victrola music and live, not in terms of necessities only, but in terms of necessities plus convenience plus pleasure. They are receptive to the good things of life.

There has been competition for the business of these families. They constitute the market, not alone for electric service and electrical household appliances, but also for kitchen cabinets, New England codfish, correspondence courses, saxophones and Persian rugs. The electrical industry, therefore, must sell its wares, and the electrical service idea which it is promoting, in keen competition with all the appeal of music in the home, convenience in the kitchen, comfort in the bedroom, enjoyment out of doors, better food, better equipment, better everything.

All these experienced competitors are persistently clamouring for attention and everlastingly keeping at it. They are telling their stories dramatically and appealingly, and that is one reason why phonographs, gas ranges and metal beds outsell clothes washers, electric ranges and ironing machines. They will continue to outsell electrical products until electrical men stop assuming that because they themselves understand the value of electrical equipment General and Mrs. Public must appreciate it also.

One of the great lessons of business which most utility men have still to learn is that their story cannot be told once or intermittently. The chorus of competing ideas ceaselessly intrudes its many voices. The electrical idea cannot hope to drown the others. It is compelled to sing with them, and if it is to be heard, it must sing well and loud and long.—*Electrical World.*

**Physical Society's Exhibition.**—The annual exhibition of scientific apparatus held by the Physical Society of London and the Optical Society will be held at the Imperial College of Science, South Kensington, on January 2nd and 3rd, 1924. This exhibition will be open in the afternoon (from 3 to 6 p.m.) and in the evening (from 7 to 10 p.m.). Mr. H. B. Grylls will lecture on "The Heape and Grylls Rapid Kinema Machine" at 4 p.m. on January 2nd, and at 8 p.m. on January 3rd; and Sir Richard Paget, Bart., will lecture on "The Nature and Artificial Production of Human Speech (Vowel Sounds)" at 8 p.m. on January 2nd, and at 4 p.m. on January 3rd. The lectures will be illustrated with experiments and lantern slides. Over 50 firms are exhibiting scientific apparatus, and a number of experimental demonstrations have been arranged.

**Machine Guards.**—The Home Office has re-issued "Safety Pamphlet No. 1" (Stationery Office, 6d. net), dealing with fencing and other safety precautions for transmission machinery in factories. The pamphlet describes and illustrates many devices for protecting employés from shafting and rotating machinery. Most of them are of a simple nature and inexpensive to install, although, of course, in such matters expense should not be the deciding factor.

**Appointments Vacant.**—Temporary engineering draughtsman (£4), for the Aberdare U.D.C. electricity department; telegraph-engineers (£600), for the Government of the Gold Coast; mains assistant, for the Bridlington Corporation electricity department; shift engineer, for the Eccles Corporation electricity works. (See our advertisement pages.)

**Power Factor and Charges to Consumers.**—As the result of a *questionnaire* recently circulated to a number of American power supply companies, the *Electrical World* draws the following general conclusions regarding power-factor as affecting the loading of systems:—

1. Rates should be simple and power-factor correction should be handled without attempting to educate customers as to the meaning of power factor and without specific mention of power factor in the rate clauses.

2. Equipment and methods have been developed whereby it has been found feasible and profitable to apply power-factor correction to large power customers.

3. In order to secure the simplest rate system, customers should be billed on kVA demand and on energy consumption. The greatest drawback to this scheme lies in the inadequacy and cost of kVA-metering equipment, and the greatest constructive step toward the adoption of this rate scheme for all customers lies in the development of a kVA-demand meter which ranks with a kWh meter in accuracy, cost and simplicity.

4. Less than a dozen central-station companies really enforce a power-factor-rate clause, and there is a decided disagreement as to the best type of clause to use. Yet executive attention and interest in the question of power-factor correction have never been greater, and the future looks promising.

5. A really workable scheme for improving the power factor of systems will save millions of dollars to the industry through eliminating the necessity for adding capacity to care for increasing loads and through increasing the production and bettering the service of power users.

6. The solution to the power-factor situation involves the use of higher-power-factor equipment, the use of corrective apparatus by both the central station and the user, and the adoption of a rate system involving both a capacity and an energy charge.

**Artificial Light and Plant Growth.**—Tests carried out by the Westinghouse Lamp Co. in conjunction with a firm of seedsmen are said to have proved conclusively that plants exposed to electric light grow at twice the rate of those exposed to daylight only. The "forced" plants had a more healthy appearance than the others after tests in the same atmospheres. The experiments indicated that all plants presenting a large leaf surface were greatly stimulated by the supplementary use of electric light. It is recognised that plants need rest, however, and it is suggested that the application of electric light should only take place during carefully-chosen hours when daylight is inadequate.

**Municipal Electrical "Old Stagers."**—Last year all those known to come within the definition of a "Municipal Electrical Old Stager" (see below) were communicated with, and all replies were in favour of holding a further re-union like the one arranged in 1922. The majority were in favour of the function being held every two years rather than annually or triennially. It was also the general opinion that the qualifications for an "Old Stager" should remain as before, viz., all those who before December 31st, 1900, were chief engineers in municipal electrical undertakings or who were assistant engineers (electrical or mechanical) before that date, and who at any subsequent time became chief engineers.

The committee which acted last time was as follows:—Mr. S. W. Baynes, Mr. J. Christie, Mr. R. S. Downe, Mr. E. T. Ruthven Murray, Mr. H. Faraday Proctor, Mr. G. Scott Ram, and Mr. C. H. Wordingham. This committee has met, and it has been arranged to hold the dinner at the Hotel Cecil on January 17th, 1924, at 7 o'clock for 7.30 p.m. As before, there will be only one toast in addition to the loyal ones, one speaker proposing and two responding. At the close of the speeches the party will adjourn to another room to talk over old times and to inspect objects of interest lent by "Old Stagers."

It is proposed to invite the following guests:—Mr. S. E. Britton, President of the I.M.E.A.; Mr. H. Booth and Sir Harry Haward, the only two Commissioners not eligible to attend as "Old Stagers"; Mr. W. L. Magden, first Hon. Secretary of the I.M.E.A.; Dr. S. Z. de Ferranti; and Mr. Spencer Hawes, who has been identified with the tables in the *Electrical Times* since they were first published.

In order to retain the distinctive character of the gathering, namely, the meeting together of old friends, practically all of whom know each other, no private or other official guests are invited. Tickets, price 25s. each, inclusive of wines, can be obtained from the hon. secretary to the Committee, Mr. C. H. Wordingham, 7, Victoria Street, S.W.1.

**The International Electrotechnical Commission.**—It having been found impossible to hold a plenary meeting of the I.E.C. in Rome this year as had been proposed, a meeting of the Council was held in Paris on December 3rd last, when delegates from ten of the National Committees were present. Dr. C. O. Mailloux, the president, who came from New York, Colonel R. E. Crompton, C.B., the honorary secretary, and Mr. C. le Maistre, C.B.E., the general secretary, were also present. Signor Guido Semenza, of Milan, was elected president of the Commission, and Dr. Mailloux, the retiring president, to whom the Commission owes so deep a debt of gratitude, was elected honorary president.

The Council appointed a committee to assist in giving effect to the decisions, to co-operate with the Central Office in carrying on its objects, and to co-ordinate the work of the National Committee as well as of the Advisory Committees. This committee will meet once or twice a year, and it is hoped thereby to accelerate the work of the Commission.

The Council also authorised the Central Office, in consultation with the President and Past President, to take the necessary steps towards the calling of a completely International Conference on Terms and Symbols for Radio Communication.

Reference was made to the International Conference on High-pressure Installations then sitting in Paris, and the Council considered that this international conference, to which it wished every success, could be of great assistance to the I.E.C. in its work by preparing the ground and carrying matters to the point where recommendations on any of the particular subjects the conference was dealing with could be submitted to the I.E.C. for action.

In Czecho-Slovakia, Hungary, and Poland, national committees, in conformity with the Statutes of the I.E.C., have been set up, and no objection was raised by the Council to those countries taking part in the work of the Commission through their properly constituted committees.

A full report of the present position of the work of the I.E.C. was presented and considered in detail, and it is hoped that through the efforts of the committee now appointed to assist the new president, material progress will be made towards obtaining concrete results which can be put before the plenary meeting at no distant date.

**Local Societies.**—Broadcast Reproduction.—Prof. Low, lecturing recently to the T.O.T. Radio Association, described the many difficulties attending the production of vocal and instrumental music by means of a loud-speaker without distortion, and urged that if this could not be done in a manner superior to the gramophone radio-telephony would not fulfil its true purpose. Dealing with the transmission of photographs and the possibilities of television, he described several methods by which both had been accomplished, but, in his view, the latter process was at present too cumbrous and costly.

Capt. Eckersley outlined the plans now under consideration for extending broadcasting over a much wider area, and dealt with the future possibilities of combined wire and wireless transmission. He described the pioneer work in this new field, which had been developed in Great Britain.

The T.O.T. Radio Association, which was formed six months ago, and has now 400 members, is composed of employés of the London Tube railway, omnibus, and tramway services.

Formby Power Station.—A paper on "The Development of the Formby Power Station" of the L.M.S. Railway Co. was read by Mr. S. E. Povey, A.M.I.E.E., at a meeting of the Students' Sections of the Liverpool Engineering Society and the Mersey and North Wales (Liverpool) Centre of the Institution of Electrical Engineers recently. The lecturer dealt with the reconstruction of the station which has just been commenced and gave a detailed description of the new boilers about to be introduced and the new generating machinery.

Radium.—A public lecture was delivered at Swansea on Saturday last by Mr. W. J. Burr, the borough electrical engineer, on "Radium and X-rays and their uses." There was a crowded audience, and the lecture was illustrated with lantern slides and animatograph films. Mr. Burr dealt with the subject in a popular manner, explaining in particular the action of radium rays on animal life, &c. X-rays, he pointed out, were in many cases the only means of detecting concealed objects and defects.

**Vacuum Holding and the Magnetic Chuck.**—Electrical engineers should be doubly interested in the vacuum chucks that have been developed by the Crescent Pump Co., Detroit, U.S.A., because there is the possibility of the vacuum and magnetic chucks coming into competition for ferrous work, while the utilisation of vacuum for holding delicate small parts in a machine or vice while they are being finished will greatly facilitate the production of rubber, fabric, wood, and non-ferrous-metal details. In some quarters the introduction of vacuum chucks has been hailed as though the principle were quite new to engineering practice, but this is not strictly correct. Much experimental work has been done in the past, and vacuum machines of one kind or another—not invariably successful—have been placed on the market. Vacuum moulding machines have been in use for many years, a rubber cup-shaped suction disk being used for raising the pattern and the vacuum made by operating foot levers, which in turn operate a foot-power pump, or in some cases control a power-driven pump.

The usefulness of vacuum will always be limited to small work. One cannot conceive of its ever competing, for instance with the electric magnet in use in steel and iron foundries and elsewhere for transporting heavy metal or sorting scrap.

It is probable that the scope of vacuum holding will be confined to small parts that are not made of iron or steel. A large number of small workshops that have no pumping plant will always prefer the magnetic chuck where it is possible to use it. For quantity production of electrical parts of frail construction there is a good use for the vacuum chuck, especially when operated with a simple and economical pumping unit; such small parts are easily distorted either when machining or filing them if they have to be clamped. In the vacuum chuck is a chamber which becomes airtight when the work is placed over it. The vacuum is then created by pumping the air from the chamber, and the work gradually becomes secured to the chuck by atmospheric pressure. That this pressure is sufficient to resist centrifugal action and permit a heavy cut to be taken while work is revolving is clear when it is remembered that on an area of 6 in. sq., if the whole bottom of a piece were exposed to vacuum, there would be an atmospheric pressure of 529 lb. There is the important disadvantage, however, as compared with electric holding, that action is not as quick and time is apt to be lost when changing. In addition, there is more work in setting because, even if the work is smaller than the chuck, the holes must all be covered—a great drawback when contrasted with the ease with which a number of small parts can be placed on a magnetic chuck or table almost without regard to position.

**Russian Radio Plant.**—The first three-phase induction motor constructed in Russia of 250 h.p., and a speed of 3,000 r.p.m., is reported to have been recently built at the works of the Petrograd Electric Machine Trust. It is intended for the operation of a 150-kW high-frequency generator, on the system devised by Prof. Vologdina, at the Chodinsk radio station, and a second machine for the same station will be constructed in the near future. Direct-current generators at 5,000 V have been taken in hand at the same works, where details are also being worked out for the construction of direct-current machines of 12 kW up to 11,000 V.

**Export of Power from Canada.**—Plans for the development of export power business between the Province of Quebec and the New England States are said to be approaching maturity. The interests controlled by Mr. E. A. Robert, president of the Montreal Tramways Co., are reported to be

behind the plan, which will involve the transmission of about 60,000 h.p. across the border. The plan would result in the disappearance of the Montreal Tramways and Power Co., holding company for the Montreal Tramways, and the formation of a new company, embracing the Quebec-New England Hydro-Electric Corporation and the Canadian Light and Power Co., as well as control of the Montreal Tramways. The project is said to include the development of 40,000 h.p. at Carillon, near Montreal, where the group controls a valuable power site, as well as at Rivière du Loup, 70 miles from Montreal, where 21,000 h.p. will be available. Contracts obtained in New England for power will, it is said, form the basis of financing the enterprise. An export licence for ten to twenty years has been requested from the authorities at Ottawa.—*Electrical World.*

**Electric Lamps for Beacons and Marine Signals.**—An interesting new field of usefulness for electric lamps has been revealed by recent experiments in the United States. Hitherto the lighting of the small beacons and buoys round the coast, or of those marking shoals in navigable rivers, has been effected mainly by oil or acetylene. One reason for this has been the lack of suitable designs of lamps; another lies in the fact that electricity is rarely available in such localities. It is therefore necessary to feed the lamps from batteries. According to an article by L. C. Porter in the *General Electric Review* (U.S.A.) these difficulties have now been largely overcome. Special automatic flashers have been devised, and lamps can also be automatically extinguished in daylight and switched on at dusk by "sun-valves" similar to those used with acetylene outfits for buoys, &c. Cells of 500-1,000-amp.-hour capacity in general answer well even if exposed to zero temperature, though if ½-1 amp. is taken, some slight protection may be desirable. With a 10-V, ½-amp. lamp equipped with a simple lens, a beam of 40 c.p. (max.) can be attained, and comparative tests show results which compare favourably with those from other illuminants. A standard electrical outfit will operate for about a year without attention, whereas oil lamps cost about 15 dollars a month for maintenance besides the cost of oil. One possible drawback, the failure of a lamp unexpectedly, can be guarded against by a special relay which brings a second lamp into operation should the first one fail. But in general, lamps do not give way during the allotted period, being designed to outlast the battery, though both are renewed together. A further advantage of the electrical system is its compactness. Renewals can be dealt with by one or two men in a motor boat at a cost of about 30 dollars a day. On the other hand, the acetylene lamps require a large light-house tender and crew costing 300 dollars a day to handle the renewals of the heavy gas tanks. An electrical outfit costs about 18 dollars a year for batteries and 1 dollar for lamps.

**Concert.**—The B.T.-H. Concert Party gave a "Light" Entertainment in connection with the B.T.H. London Club at "Our" Theatre, 1, Gerrard Place, W., on Tuesday evening last.

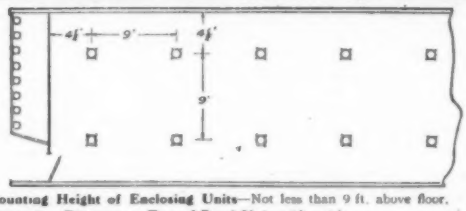
**The British Association.**—The date of the British Association meeting in Toronto next year, provisionally announced for September 3rd-10th has now been altered to August 6th-13th, and the meeting will be followed by official excursions, not preceded by them, as originally proposed. The meeting will be under the presidency of Sir David Bruce. Preparations are already in active progress both in Toronto and in London. The American Association for the Advancement of Science intends to hold a short meeting in Buffalo immediately before that of the British Association in Toronto, and reciprocal arrangements are being made for the admission of members of either Association to the meetings of the other. The Association, which will meet in Southampton in 1925, has received from the University and City of Oxford an invitation to meet there in 1926, which will in due course be laid before the general committee of the Association.—*The Times.*

**Extensions in the United States.**—The tremendous developments which are taking place in the electricity supply industry of the United States are apparent from tables published recently by the *Electrical World.* From these it is seen that extensions of steam plant and new stations in hand represent in the aggregate 3,052,850 h.p. Outstanding items in the list are the following:—Public Service Electric Co. (New Jersey), 400,000 h.p.; Philadelphia Electric Co., 330,000 h.p.; Commonwealth Edison Co., 227,000 h.p.; Detroit Edison Co., 150,000 h.p.; and Northern States Power Co., 124,000 h.p. Hydro-electric stations and extensions are in hand to the extent of 2,057,100 h.p. The following are the principal undertakings in this section:—Alabama Power Co., 283,000 h.p.; Niagara Falls Power Co., 210,000 h.p.; Southern Power Co., 190,000 h.p.; San Francisco Municipality, 100,000 h.p.; and Georgia Railway & Power Co., 92,000 h.p. The estimated cost of the whole of these new stations and extensions is $536,708,750.

**A Lecture on Light.**—On November 29th Mr. F. H. Taylor, A.M.I.E.E., gave a lecture on "Light: from the Ancient to the Modern," in aid of the fund for the restoration of St. Mary's Church, Stoke Newington, the lighting of which was described in our issue of May 4th (p. 700). The lecture was a review of the progress of illumination from the earliest times of which we have knowledge to the present-day electric lighting. A short note on artificial daylight concluded the lecture.

**Lighting Service.**—It is being recognised by many manufacturers that the mere supplying of goods is not enough and that they must be prepared to give expert assistance to the users of their products. They further see that any such assistance will often have as much application to similar appliances or systems evolved by others, but this does not nowadays deter them; there is an increased manifestation of a desire to promote the well-being of an industry as a whole. In this connection the handbooks on "Lighting Service" now being published by the British Thomson-Houston Co., Ltd., show that the electrical industry has been imbued with this spirit. These brochures do not mention the B.T.H. Co., but set out to inform the reader how to get the best out of the electric lamp. The second of these handbooks deals with the lighting of stores and shops, and the method of treatment adopted is best explained by the reproduction of one of the pages herewith. This is an excellent example of shop-interior lighting in which a very even distribution appears to have been obtained, and the mode of its attainment is fully set forth.

**Design 5a. Shop 18 ft. wide Ceiling Height 10-12 ft.**




**Mounting Height of Enclosing Units**—Not less than 9 ft. above floor.
**Suspension Distance to Top of Bowl Units**—1½ to 2 ft.

**Approximate Average Foot-Candles Using 150-watt* Gasfilled Lamps**

| Type of Fitting | Light Ceiling | | Medium Ceiling | Dark Ceiling |
|---|---|---|---|---|
| | Light Walls | Medium Walls | Medium Walls | Dark Walls |
| Enclosing—Light Diffusing ... | 7 | 6 | 5½ | 4 |
| Enclosing—Light Directing, or Semi-Enclosing ... ... | 8 | 7 | 6½ | 6 |
| Semi-Indirect or Totally Indirect ... ... ... | 6 | 5½ | 4½ | — |

**Display Windows**—Points as shown represent usual practice for average display window. See pages 36 to 40.

* To obtain approximately the same foot-candle values with Daylight lamps, use 200-watt size.

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DATA OF SHOP LIGHTING.

## INSTITUTION NOTES.

**Institution of Electrical Engineers.**—EAST-MIDLAND SUB-CENTRE.—On December 11th, at Loughborough, Mr. E. G. Phillips, of Nottingham, took the chair at a meeting at which Mr. J. D. Morgan, M.Sc., M.I.E.E., A.M.Inst.C.E., chairman of the Midland Centre of the Institution, read a paper on "Social Reactions of the Work of an Engineer." The speaker based the first part of his lecture on a quotation from the work of Dr. Austin Freeman to the effect that "Mechanism with its reactions on man and his environment has been, and is still, antagonistic to human welfare." This theory was further supported by references to the work of Dean King and the "Metamorphoses" of Ovid, who, 2,000 years ago, spoke of man as being "By steel assaulted and by gold betrayed." At the present day, said Mr. Morgan, a dreadnought was as much the symbol of the world as was the cathedral of other days, and supporters of Dr. Freeman alleged that the development of machinery had debased the individual and diverted the progress of mankind from its natural channels. The worker of to-day was rendered unhappy by the dreary monotony of repetition work, and had lost the joy in his work which distinguished ancient craftsmen. He was also losing the quality of self-reliance and æsthetic culture.

The lecturer then set himself to prove that such claims were for the most part based on a faulty comparison between the

work of craftsmen of great skill with that of the present-day operator, who should rightly be compared with the old-time labourer. It was a mistake to suppose that inferior goods were solely a modern product, and he agreed with Mr. H. G. Wells that the craftsman of to-day was more adaptable than his forefathers and, further, that to-day, by the possession of a fuller working knowledge of the intricacies of his subject, he was enabled to reap a fuller reward for his toil.

If it were possible to exist as a horticultural society living entirely on the fruits of the earth, as, for example, actually occurred in ancient Eastern civilisations, undoubtedly the world would be a happy one, and Dr. Freeman would be right in his deduction that the work of engineers had not materially benefited mankind. Unfortunately, they could not escape the truth that a horticultural society was a prey to famine, which might sweep across a country and wipe out a people. For that reason, industrialism was inevitable. Rome and Greece had their systems of industrialism, but those old-world systems were built up on slavery. Therefore, with the awakening of a sense of moral responsibility, inevitably came industrialism as it was known to-day, and the horror of famine had been replaced by the horror of unemployment.

Nevertheless, the lecturer believed that whatever the evils of the industrialism of to-day, they must recognise that they could not compare with those of slavery, and that there was no escape from the evidence of progress in the world. For present-day problems many solutions were offered; to him it seemed that much depended on the individual MAN.

Western Centre.—At Swansea, on Monday, Mr. C. T. Allan (chairman) presiding, Mr. S. Austen Stigant, A.M.I.E.E., M.Am.I.E.E. (manager, Transformer Department, Johnson and Phillips, Ltd.) read a paper illustrated with many lantern slides on "Causes of Transformer Failures"—a subject he dealt with in the Electrical Review of December 1st and 8th, 1922. An interesting discussion followed, in which Sir Whitten Brown (Metropolitan-Vickers), Mr. James, Mr. Isaac, Mr. J. W. Burr (borough electrical engineer), the chairman, and others took part.

Local Centre in China.—The Council of the Institution has sanctioned the formation of a local centre in China, with headquarters at Shanghai.

**Institution of Mechanical Engineers.**—Annual Dinner.—The annual dinner of the Institution was held on December 13th at the Connaught Rooms, Sir John Dewrance, the president, occupying the chair.

Sir L. Amherst Selby-Bigge (Permanent Secretary, Board of Education), in proposing the toast of "The Institution of Mechanical Engineers," said that the Institution had rapidly grown during the 76 years of its existence; the membership had increased by 740 since 1921, in spite of the fact that the entrance examination had been made more severe.

The president, in responding to the toast, said that a new research fund, called the George Stephenson Fund, had been formed, owing to the beneficence of Prof. Coker. Mr. W. H. Allen had presented £1,000 to the fund for the purpose of sending one student, selected by the Institution, to Cambridge for three years. The toast of "The Visitors" was proposed by Mr. William H. Patchell (president-designate).

**Junior Institution of Engineers.**—Midland Section.—Dr. C. C. Garrard (General Electric Co., Ltd.) delivered his presidential address to the Midland Section of the Junior Institution of Engineers at Birmingham on Thursday last week. He insisted that one of the first things to do was to establish and conserve the professional standard of the engineer's work. The day of small engineering concerns was over. Small-scale organisation was wasteful, while large-scale organisation afforded the means of emancipation for the engineer by the possibility it gave him of acquiring control, for such a scheme eliminated the financial adventurer.

## OUR PERSONAL COLUMN.

***The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the Electrical Review posted as to their movements.***

We are glad to be able to record that Mr. W. A. Chamen, engineer and general manager of the South Wales Electrical Power Distribution Co., who has been seriously ill, is now making satisfactory progress towards recovery.

Councillor Wenban Smith has been re-elected chairman of the Electricity Committee of the Worthing Town Council.

Alderman R. Montz has been elected chairman of the Hornsey Town Council Electricity Committee.

*The Sydney Daily Telegraph* published the following in October:—"The Sydney City Council's electricity supply is assuming such large dimensions and giving rise to such difficult problems that the general manager (Mr. Forbes Mackay) recommends that the deputy-general manager (Mr. Maling) should visit England, America, and probably France, to obtain the latest information on matters vitally important in the economical running of the Council's undertaking. Included are: Overhead high-tension mains, which are persistently failing through storms; more efficient lightning arresters; the cleaning of high-tension insulators; the distribution of electricity in large areas, as alarm is being felt at the rapid rate of increase in the aggregate cost of sub-stations; the discharge of ash and grit from power-house chimney stacks; and corrosion. Some alarm is felt at the inroads made by corrosion in the tubes of the condensers, economisers, new boilers, and also in the blading of the steam turbines. At the present rate of deterioration, it is understood that it will cost the Council some thousands of pounds every year to replace corroded parts, unless some means can be found for checking the corrosion. Mr. Mackay returned about two years ago from a second trip abroad, when he inquired into the question of electricity generation and supply on behalf of the Council. The Lord Mayor recommends that Mr. Maling should make the trip, and that he be given seven months' leave, and £1,500 to cover his travelling expenses."

Portsmouth Town Council has appointed Mr. William E. Newberry as main assistant at the electricity works at a salary of £300 per annum.

Ald. J. B. Burman, M.P., chairman of the Birmingham Corporation Electric Supply Committee, has intimated his intention to resign the chairmanship owing to the heavy calls upon his time. He will probably be succeeded in that position by Councillor Beale. There are now two members of Parliament upon the Birmingham Electric Supply Committee—Alderman Burman and Alderman Jephcott; both will continue to serve on the City Council.

Mr. H. W. Healy, A.M.I.E.E., assistant engineer to the Gramophone Company, Ltd., Hayes, Middlesex, has entered into partnership arrangements with the Electro Flow Meters Co., of 109, Kingsway, London, W.C. 2. Mr. Healy will concentrate on centralised control instrument equipment for application to central station and industrial power plant, and correspondence for him should be addressed to the Kingsway offices, as above.

Dr. T. F. Wall has been appointed External Examiner in Electrical Engineering in the Queen's University, Belfast.

Mr. H. Wilson is resigning the position of distribution engineer at the Croydon Electricity Works in order to take up a similar position at Paisley, in place of Mr. W. R. Fitton, who has accepted a position as chief electrical engineer with the Anglo-Persian Oil Co., Ltd., in Persia. Mr. Wilson was mains superintendent at Maidstone before taking up his post at Croydon in 1921.

**Obituary.**—Mr. C. H. W. Biggs.—In *The Times* of Saturday last, under "Deaths," an announcement appeared stating that Mr. Charles Henry Walker Biggs, husband of Susan Biggs, had passed away on December 13th, at 42, Therapia Road, Honor Oak, S.E. Mr. Biggs was very actively and prominently interested in electrical movements quite as far back as forty years ago. He was the proprietor of a paper which ran for a good many years under the title *The Electrical Engineer*, and which was subsequently amalgamated with *Electrical Engineering*, which later ceased its existence. He was also a publisher of technical works.

## NEW COMPANIES REGISTERED.

**Radio Improvements, Ltd.** (194,272).—Private company. Registered December 7th. Capital, £100 in £1 shares. To carry on the business of manufacturers of, agents for, dealers in all kinds of wireless and electrical apparatus, &c. The first directors are:—W. H. Le Breton (managing director), 95, Great Portland Street, W., electrical engineer; R. Woods, 95, Great Portland Street, W., electrical engineer; Miss E. J. W. Senier, 95, Great Portland Street, W. Registered office: 95, Great Portland Street, W.1.

**Farringdon Electrical Co., Ltd.** (194,259).—Private company. Registered December 7th. Capital, £21,000 in 20,000 10 per cent. cumulative preference shares of £1 and 20,000 ordinary shares of 1s. To carry on the business of manufacturers of, agents for, and dealers in electrical apparatus and appliances, &c. The subscribers (each with one preference share) are:—A. E. Fenton, 90, Cannon Street, E.C.4, solicitor; S. Gardner, 90, Cannon Street, E.C.4, solicitor. The first directors (to number not less than two or more than six) are:—C. A. R. Scott, E. C. Given, Sir Harry Greer (chairman), Sir Charles Shaw, and J. C. Williamson. Sir Harry Greer, Sir Charles Shaw, and J. C. Williamson may each retain office so long as John Shaw & Son (Wolverhampton), Ltd., or their successors, by themselves or their nominees, hold 10,000 preference shares. The appointees of the said company may appoint the chairman. The managing director of John Shaw & Son (Wolverhampton), Ltd., shall be entitled to attend all board meetings, but shall not be entitled to vote. Qualification, 100 shares. Remuneration as fixed by the company. Registered office: 13, Farringdon Road, E.C.1.

**Midlands Exhibitions, Ltd.** (194,316).—Private company. Registered December 10th. Capital, £2,000 in £1 shares (500 preference and 1,500 ordinary). To acquire the business of exhibition promoters now carried on by H. E. Wilson and J. H. Wilson at Northampton as the "Midland Counties Motor, Wireless, and General Trades Exhibition," and to carry on the business of exhibition proprietors, showmen, entertainers, theatrical proprietors, agents, and managers, kinematographers, film makers and exhibitors, kinematograph proprietors, advertisers and advertising agents, &c. The first directors are:—Sir James Crockett, Kt., "The Lodge," Ballington, Northants.; T. Y. Castell, "Lamport," Northants., farmer; H. E. Wilson, "Glyndon," Woburn Sands, fish merchant; J. H. Wilson, 5, Castilian Terrace, Northampton, auctioneer and valuer; A. E. Hewitt, North Western Hotel, Marefair, Northants., hotel proprietor. The said H. E. Wilson and J. H. Wilson shall be permanent, subject to holding 50 shares each. Qualification, £50 shares. Solicitor: J. H. Woodford Robinson, 16, Guildhall Road, Northampton.

**Pryce, Ltd.** (12,927).—Private company. Registered in Edinburgh December 7th. Capital, £1,000 in £1 shares. To carry on the business of electrical and motor engineers, plumbers, and contractors, &c. The first directors are:—W. H. Boyd, "Mount Stewart," Bo'ness, motor engineer; J. G. Pryce, 18, Marshlands Avenue, Bo'ness, electrical engineer. Qualification, 50 shares. Registered office: Corbiehall, Bo'ness.

**Sphinx Electric Supplies (Ireland), Ltd.**—Private company. Registered in Dublin December 5th. Capital, £100 in £1 shares. To carry on the business of electrical engineers and contractors, &c. The first directors are:—C. P. Preston, 6, Clanwilliam Place, Lower Mount Street, Dublin (sales manager of Auto Bulbs, Ltd., London); P. Adair, 6, Clanwilliam Place, Lower Mount Street, Dublin (director, P. Adair, Ltd., 32, Holborn Viaduct, E.C.). Secretary: V. Faloone. Registered office: 6, Clanwilliam Place, Dublin.

**Bell's (Yorks.), Ltd.** (194,288).—Private company. Registered December 8th. Capital, £100 in £1 shares. To carry on the business of manufacturers of, and dealers in all kinds of dynamos, electric motors, batteries, electric lighting and starting sets, and apparatus for motor cars, lorries, and char-a-bancs, generators of electricity, &c. The subscribers (each with one share) are:—M. Myers, 222, Harehills Avenue, Leeds, optician; G. Hawley, Gordon Cottage, Sherburn-in-Elmet, Yorks., clerk. M. Myers is first director. Registered office: 25, Upperhead Row, Leeds.

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**B. N. B. Wireless, Ltd.**—Particulars filed of £500 second debentures authorised November 5th, 1923, charged on the company's undertaking and property, present and future, including unpaid capital, subject to a first debenture of £500, the whole amount being now issued.

**Church Stretton Electric Supply Co., Ltd.** — Further charge on certain land and premises at Church Stretton, Salop, and the Church Stretton Electric Lighting Order, 1916, and all rights, powers, and privileges thereby conferred or granted dated November 21st, 1923, to secure £1,800. Holders: Church Stretton Developments, Ltd., 27, Chancery Lane, W.C.

**Electrolux, Ltd.**—Debenture charged on the company's undertaking and property, present and future, including uncalled capital, dated November 23rd, 1923, to secure all moneys due or to become due from the company to Lloyd's Bank, Ltd.

**Alpha Manufacturing Co., Ltd.**—Debenture dated November 30th, 1923, to secure £1,000 charged on the company's property, present and future, including uncalled capital. Holder: W. F. Mason, Wickham House, Beaufort Road, Kingston-on-Thames.

**C. H. Mason & Co., Ltd.**—Further charge on property in and near West Street, Gateshead, and as collateral security thereto a debenture, charged on the company's undertaking and property, present and future, including uncalled capital, both dated November 30th, 1923 (supplemental to indenture dated August 9th, 1922), to secure all moneys due or to become due from company to the Bank of Liverpool and Martins, Ltd., in excess of £11,500 secured by the original indenture.

**Woods-Gilbert Rail Remodelling Co., Ltd.**—Satisfaction in full on November 15th, 1923, of debenture dated May 18th, 1921, securing any bank overdraft.

**General Electric Co., Ltd.**—Satisfaction to the further extent of £37,400 on November 20th, 1923, of debenture stock dated July 22nd, 1921, securing £3,500,000.

**Leatherhead and District Electricity Co., Ltd.**—Satisfaction in full on October 9th, 1923, of debentures dated February 7th, 1921, securing £9,150.

**Moodys, Ltd.**—W. A. J. Osborne, of 119, Finsbury Pavement, E.C., ceased to act as receiver or manager on December 3rd, 1923.

**Car Ignition and Lighting Co., Ltd.**—J. P. Cave, of 29, Martin Lane, Cannon Street, E.C., was appointed receiver on December 5th, 1923, under powers contained in debentures dated January 4th, 1923.

**Hightensite, Ltd.**—C. Comins, of 50, Cannon Street, E.C.4, ceased to act as receiver or manager on November 28th, 1923.

**Electric Reduction Co., Ltd.** (54,724).—Return dated November 12th, 1923. Capital, £50,000 in 16,200 preference and 33,800 ordinary shares of £1 each. 16,200 preference and 28,800 ordinary shares taken up. £18,000 paid on 13,000 preference and 5,000 ordinary shares. £27,000 considered as paid on the remainder. Mortgages and charges, £25,000.

**Synchronome Co., Ltd.** (120,465).—Return dated December 31st, 1922 (filed July 25th, 1923). Capital, £2,000 in 1,400 ordinary and 600 preference shares of £1 each. All shares taken up. £700 paid. £1,300 considered as paid. Mortgages and charges, nil.

## CITY NOTES.

**Telephone Manufacturing Co., Ltd.**

The accounts for the year ended May 31st last show that the profits were £73,004, which includes dividends received from installation companies amounting to £31,980 gross. According to the *Financier* the balance brought forward was £7,136, making a total of £80,141. From this must be deducted accrued income bond interest, and income tax amounting to £30,979, leaving available £49,161. The directors have declared an interim dividend of 5 per cent., less tax, amounting to £15,460, leaving £33,701, which is to be applied as follows: Writing off part expenses of income bond issue, £10,000; contingency reserve £17,500, leaving to be carried forward, subject to directors' additional remuneration, £6,201. The directors have decided to declare the above-mentioned interim dividend of 5 per cent. owing to the impossibility of holding the annual general meeting before January next. The shareholders will be asked at the annual general meeting to confirm this dividend as a final one for the year. In view of the continued and increased industrial depression which has been experienced during the whole of the period the directors consider the result of the year's trading satisfactory. Nothing is included in the accounts in respect of profits earned during the year by installation companies abroad, owing to the depreciated foreign exchanges now ruling. In order to provide against possible losses in this direction the directors have decided to form a contingency reserve fund.

**German Electrical Companies.**

*The Rheydt Electrotechnical Works* (*Max Schorch & Co.*), of Rheydt, records net profits of 40.4 millions of marks for 1922-23, as compared with 5.4 millions in the previous year, when a dividend at the rate of 25 per cent. was declared. The profits for the past year have been carried forward.

*The Bank of Electrical Values, of Berlin*, which is an investment company, reports that all the undertakings closely connected with the bank yielded satisfactory results in 1922-23. The net profits permit of the payment of a dividend at the rate of 1.05 gold marks per ordinary share, or the equivalent of a quarter of a dollar in gold loan.

*The Poege Electricity Co. of Chemnitz* reports that the undertaking was well occupied in 1922-23, and the dividend recommended is at the rate of 30 per cent. The directors state that owing to the general economic crisis, business in the new financial year has declined, although they recall the fact that the company has on hand orders from the Federal railways for the supply of the electrical equipment for heavy goods and passenger locomotives of approximately 2,000 h.p.

**Dunblane Electricity Supply Co., Ltd**

At an extraordinary meeting on December 13th proposals were submitted and accepted for the purchase of the undertaking by Messrs. Balfour, Beatty & Co., London. The chairman described the difficulties which the company had had to meet since it was formed three years ago. Messrs. Balfour, Beatty & Co. were prepared to pay all the company's expenditure to date, amounting to £1,552, and return the shareholders' money, with the addition of 5 per cent. The shares are £1 shares, 10s. paid, and the Balfour offer is 10s. 6d. It is expected that the new company will have the supply introduced into Dunblane about May next.

**Stock Exchange Notices.**—Applications have been made to the Committee to allow the following to be officially quoted:—

Andhra Valley Power Supply Co.—£1,000,000 7½ per cent. 10-year secured sterling notes.

City and South London Railway Co.—Scrip, fully and partly paid, for £3,769,000 4½ per cent. redeemable second debenture stock, 1942-72.

London Electric Railway Co.—Scrip, fully and partly paid, for £2,356,000 4½ per cent. redeemable second debenture stock, 1942-72.

Kalgoorlie Electric Power and Lighting Corporation.—£128,318 6 per cent. income debenture stock.

Tata Power Co.—Scrip, fully and partly paid, for £1,000,000 4½ per cent. guaranteed "A" mortgage debenture stock, 1929-48.

**Tucuman Tramways, Light and Power Co.**—According to the *Financial Times* the directors propose to deal with the balance of £63,562 standing to the debit of the profit and loss account by writing off £50,000 by the reduction of capital and by crediting to the profit and loss account a sufficient amount from the debenture stock redemption reserve account. Meetings were called for December 19th to consider resolutions to reduce the capital from £611,000 to £561,000 by cancelling paid-up capital to the extent of 10s. per share on each of the 100,000 deferred shares and by reducing the nominal amount of each of such shares from £1 to 10s.

**A Swiss Electrical Company.**—A loss of 678,256 fr. is shown in the report of the Société des Usines Electrique de la Lonza, of Basle, for the last financial year, bringing up the total loss shown in the balance sheet to 1,458,090 fr. It is understood that the directors will shortly introduce a scheme for the re-organisation of the company's finances.

**Charing Cross, West End and City Electricity Supply Co., Ltd.**—A meeting was held on December 19th to consider a scheme for sub-dividing the £5 shares into five £1 shares, converting the unissued preference shares into ordinary shares, and giving the company power to make a bonus issue.

**Eastern Telegraph Co., Ltd.**—Third quarterly interim dividend of 2½ per cent. on the ordinary stock, free of income tax, in respect of profits for the year ending December 31st, 1923.

**Eastern Extension, Australasia and China Telegraph Co., Ltd.**—Interim dividend for the three months ended September 30th of 5s. per share, payable free of income tax.

**Victoria Falls and Transvaal Power Co.**—Six months' dividend at the rate of 6 per cent. per annum, less tax, on the preference shares.

**Chili Telephone Co., Ltd.**—Interim dividend of 3s. per share, free of tax, being at the rate of 6 per cent. per annum.

**Manila Electric Corporation.**—Dividend of 2 per cent. for the quarter ending December 31st on common stock.

**Automatic Telephone Manufacturing Co., Ltd.**—Dividend on the 6 per cent. preference shares for the past half-year.

## STOCKS AND SHARES.

MONDAY EVENING.

THE growing fears of a Capital Levy have shaken Stock Exchange markets very severely. It may be said that prices have received no such shock for years past. Every market in the Stock Exchange felt the force of selling. A good many gamblers got out of their depth; the forced realisation of their accounts has added to the depression that ruled from the Consol market to the Kaffir Circus. It is peculiarly unfortunate that such a crisis should have arisen at the end of the year. Even in ordinary days, the last settlement in December finds people reluctant to spend money in stocks and shares. They like to have as much balance as they can accumulate, in order to present a fair appearance at their banks. Moreover, money always tends to become a little tighter as the year ends, and at the same time, a mild amount of selling takes place on behalf of those people who make a point of weeding-out their superfluous stocks before they make up their books on New Year's Eve. These incidental factors contribute to the reasons for the slump that has overtaken the markets. Not many falls occurred in the list of Home electricity issues. Mexicans, however, are again lower, and the Home Railway market suffered severely from realisations.

The Charing Cross Electricity Supply Co. has given formal notice of a meeting to be held for passing resolutions that will provide for the splitting of the present £5 shares into others of £1 each. This brought about a rise of 25s. to 14½ in Charing Cross shares. The Westminster Company and the St. James's are expected to follow suit. Westminsters are ½ up at 10 5/16. St. James's retain their rise of last week at 11½. Trifling losses occurred in Edmundsons and City Lights, but the list as a whole is the steadiest without exception to be found round the Stock Exchange. For this strength, no fresh explanation need be added to that which has been given in this column from time to time during the past six months, but proprietors of electricity supply shares must be feeling profound satisfaction at the way in which their market has withstood the slump that has descended upon everything else in consequence of the fear lest a Capital Levy come into operation.

The Labour party has another plank, Nationalisation, in its programme, and this spells caution to the investor in Home Railway stocks. Consequently, Metropolitans have fallen 2½, and Districts 2 points during the past few days. Underground Electric ordinary shares are 7s. 6d. down; the "A" shares fell 1s. 6d. to 9s. The idea is current that the Labour Party adopts a hostile attitude to anything in the shape of a trust or combination, and the Underground Electric Railways of London issues were heavily sold by those to whom the prospect of Labour coming into power afforded reasons for anxiety.

Marconis are quoted ex the dividend of 2s., but making allowance for this, the price at 2 is a few shillings easier. Other Marconi shares have also given way, the preference being down to 35s., Marconi debenture to 105½, and Canadian Marconis to 5s. 9d.

Cable stocks keep tolerably steady. There is a fall of ½ in Eastern Extensions, and Western Telegraphs, ex their usual 5s. dividend, are down a similar amount on balance. Declaration of the regular quarterly dividends by the Eastern Telegraph Co. and Eastern Extension served to buttress the market against possible selling, and jobbers have not considered it necessary to lower the prices, as they have done in many other departments, against the possibility of sellers coming in.

London & Suburban Traction preference fell further to 7s., a drop of 1s. this week, on the fears, already reflected here, lest the February dividend may not be paid. Mexicans are flat all round. The falls range from 1 to 4 points, and are the result of news from the country to the effect that the revolutionaries have shown increased activity. To what extent the utility companies are likely to be damaged, it is, of course, impossible to say, but the mere apprehension of the capital being captured by the insurrectionists, caused an outbreak of would-be selling, which, however, was not always successful in finding support. Brazil Tractions are a point down at 45. Cawnpore Electric eased off to 23s. 9d. Anglo-Argentine Tramways second preference went back to 3, and the company's first debenture stock is a little easier at 77½.

Metropolitan-Vickers preference at 2 7/16 are 3/16 lower. A good deal of business is doing in the ordinary shares on the basis of 27s. 6d. British Thomson-Houston preference drooped to 22s. Callenders at 48s. 9d. are a little easier. Telegraph Constructions fell another 10s. to 24, and India Rubber shares, ex a shilling dividend, are weaker on balance at 13s. 9d. Edison-Swans reacted to 4s. 6d., on selling by people who had bought shares in advance of the dividend announcement. English Electrics are a trifle lower at 17s. 6d.

Babcock & Wilcox fell to 2 3/16, this decline being but one of a lugubriously long list of falls in iron, steel and engineering shares. This market is particularly weak, the selling from the North being persistent, and encountering no assistance from the London Stock Exchange. Bournemouth and Poole Electric new ordinary are steady at 2s. 9d. premium, but other new issues have come under the influence of the prevailing depression, and show losses in most cases, as compared with the prices of a week ago. Rubber shares are weak with the rest, and the disposition of markets as a whole is the reverse of cheerful.

## SHARE LIST OF ELECTRICAL COMPANIES.

| | Nom. | Dividend. 1921. | Dividend. 1923. | Price Dec. 17, 1923. | Rise or fall. | Yield p.c. |
|---|---|---|---|---|---|---|
| **HOME ELECTRICITY COMPANIES.** | | | | | | |
| Brompton Ordinary | £1 | 12 | 12 | 2 1/16 | — | £5 16 8 |
| Charing Cross Ordinary | £5 | 9 | 14 | 14½ | +1½ | 4 16 7 |
| do. do. do. 4½ Pref. | £5 | 4½ | 4½ | 4 5/16 | — | 5 4 4 |
| Chelsea | £1 | 6 | 10 | 37/- | — | 5 11 1 |
| City of London | £1 | 14 | 15 | 2 7/16 | —9d. | 6 3 0 |
| do. do. 6 % Pref. | £1 | 6 | 6 | 24/- | — | 5 4 4 |
| County of London | £1 | 8 | 10 | 2 1/16 | — | 4 16 10 |
| do. do. 6 % Pref. | £1 | 6 | 6 | 23/3 | — | 5 3 3 |
| Edmundson's Ordinary | £3 | Nil | 7 | 4 | — ½ | 5 5 1 |
| do. 6 % Pref | £5 | 12/- | 6 | 5½ | — | 5 14 3 |
| Kensington Ordinary | £5 | 10 | 12 | 10½ | — | 5 18 5 |
| London Electric | £3 | 4 | 10 | 4 1/32 | — | 6 1 7 |
| do. do. 6 % Pref. | £5 | 6 | 6 | 5½ | — | 5 9 1 |
| Metropolitan | £1 | 7 | 8½ | 34/- | — | 5 0 0 |
| do. 4½ % Pref. | £1 | 4½ | 4½ | 17/6 | — | 5 2 10 |
| Newcastle-on-Tyne Ordinary | £1 | Nil | 2½ | 15/6 | — | 3 4 6 |
| do. 5 % Pref. | £1 | 5 | 5 | 15/9 | — | 6 7 0 |
| do. 7 % Pref. | £1 | 7 | 7 | 23/- | — | 6 1 9 |
| Notting Hill 6 % Pref. | £10 | 6 | 6 | 9½ | — | 6 6 4 |
| North Met. Elec. 6 % Pref. | £1 | 6 | 6 | 23/- | — | 5 4 4 |
| Urban Ordinary | £1 | Nil | — | 18/9 | +1/9 | Nil |
| do. 6 % Pref. | £1 | 9½ | 5 | 18/9 | + 1/16 | 6 9 4 |
| St. James' and Pall Mall | £5 | 13 | 14½ | 11⅜ | — | 6 4 9 |
| South London | £1 | 7 | 10 | 1 1/32 | — | 5 3 3 |
| South Metropolitan Pref. | £1 | 7 | 7 | 24/6 | — | 5 14 3 |
| Westminster Ordinary | £5 | 10 | 12 | 10 1/32 | + ½ | 5 16 3 |
| Whitehall Elec. Invst., 7½ % Pf. | £1 | 7½ | 7½ | 19/9 | —6d. | 7 12 0 |
| **HOME RAILS.** | | | | | | |
| Central London Ord. Assented | Stock | 4 | 4 | 73 | — | 5 9 7 |
| Metropolitan | ,, | 9½ | 8½ | 72 | —2½ | 4 17 3 |
| do. District | ,, | 1 | 3 | 54 | —2 | 5 11 1 |
| Underground Electric Ordinary | £10 | Nil | Nil | 2¼ | — ⅛ | Nil |
| do. do. "A" | £1 | Nil | Nil | 7/6 | —1/6 | Nil |
| do. do. Income Bonds | £4 | 5 | | 101 | — | *4 19 0 |
| **TELEGRAPHS AND TELEPHONES.** | | | | | | |
| Anglo-Am. Tel. Pref. | Stock | 6 | 6 | 103½ | — | 5 15 11 |
| do. Def. | ,, | 1½ | 34/6 | 23½ | — | 6 9 0 |
| Chile Telephone | £5 | 6 | 6 | 6 | — | 5 0 0 |
| Cuba Sub. Ord. | £10 | 7 | 7 | 7½ | — | 9 13 2 |
| Eastern Extension | £10 | 10 | 10 | 16⅝ | — ½ | 5 19 3 |
| Eastern Tel. Ord. | Stock | 10 | 10 | 167½ | — | 5 19 5 |
| Globe Tel. and T. Ord. | £10 | 10 | 10 | 17½xd | — | 5 16 0 |
| do. do. Pref. | £10 | 6 | 6 | 11½xd | — | 5 7 7 |
| Great Northern Tel. | £10 | 24 | 22 | 28½ | — | 7 16 0 |
| Indo-European | £5 | 10 | 7 | 83½ | — | *5 7 8 |
| Marconi | £1 | 25 | 15 | 2½xd | —4/- | 7 19 0 |
| Oriental Telephone Ord. | £1 | 13 | 13 | 1⅝ | — | *6 8 0 |
| United R. Plate Tel. | £5 | 8 | 8 | 6⅞ | — | *5 16 4 |
| West India and Panama | £10 | Nil | Nil | 1/- | — | Nil |
| Western Telegraph | £10 | 10 | 10 | 16xd | — ½ | *6 5 0 |
| **HOME AND FOREIGN TRAMS, &c.** | | | | | | |
| Anglo-Arg. Trams. First Pref. | £5 | 5½ | 12½ | 9⅜ | — | 8 16 0 |
| do. do. 2nd Pref. | £5 | Nil | 8½ | 3 | — ½ | 10 0 0 |
| do. do. 5% Deb. | Stock | 5 | 5 | 76 | — | 6 11 7 |
| British Electric Traction Ord. | ,, | 4½ | 5 | 70 | — | 7 2 10 |
| do. do. 6% Pref. | ,, | 6 | 6 | 98½ | — | 6 1 10 |
| Brazil Traction | £100 | Nil | 4 | 45 | —1 | 8 18 0 |
| Brit. Columbia Elec. Rly. Pos. | Stock | 5 | 5 | 84½ | — | 5 18 4 |
| do. do. Preferred | ,, | 5 | 96/- | 85 | + ½ | *5 13 0 |
| do. do. Deferred | ,, | 8 | 127/- | 98½ | — | *6 8 6 |
| do. do. Deb. | ,, | 4½ | 4½ | 77½ | — | 5 9 8 |
| Lond. & Sub. Trac. 5 % Pref. | £1 | 3½ | 5 | 7/- | —1/- | 12 10 0 |
| London United Tram. Deb. | Stock | 4 | 4 | 59 | — | 6 13 4 |
| Mexico Trams. 5 % Bonds | — | Nil | Nil | 29½ | —3 | 7 4 0 |
| do. 6 % Bonds | — | Nil | Nil | 57½ | —1 | Nil |
| Mexican Light Common | £100 | Nil | Nil | 19 | —1 | Nil |
| do. Pref. | £100 | Nil | Nil | 47½ | —2½ | Nil |
| do. 1st Bonds | — | Nil | 6 | 61½ | —4 | 8 2 8 |
| **MANUFACTURING COMPANIES.** | | | | | | |
| Babcock & Wilcox | £1 | 15 | 20 | 2 3/16 | — 1/16 | *4 11 4 |
| British Aluminium Ord. | £1 | 10 | 5 | 18/9 | —9d. | 5 2 7 |
| British Insulated Ord. | £1 | 15 | 15 | 2 15/16 | — | 6 0 0 |
| Callenders | £1 | 15 | 15 | 2 7/16 | —9d. | 6 3 0 |
| do. 6½ Pref. | £1 | 6½ | 6½ | 25/- | — | 5 4 0 |
| Crompton Ord. | £1 | 10 | 5 | ½ | — | 10 0 0 |
| Edison-Swan | 4/- | 10 | Nil | 4/6 | —6d. | 6 13 4 |
| do. do. 5% Deb. | Stock | 5 | 5 | 67½ | — | 7 8 2 |
| Electric Construction | £1 | 10 | 10 | 29/6 | — | 6 15 7 |
| English Electric | £1 | 8 | 5 | 17/6 | —6d. | 5 14 3 |
| do. do. Pref. | £1 | 6 | 6 | 19/6 | — | 6 3 1 |
| Gen. Elec. Pref. | £1 | 6½ | 6½ | 22/6xd | — | 5 15 7 |
| do. Ord. | £1 | 10 | 5 | 1 | — | 5 0 0 |
| Henley | £1 | 15 | 15 | 49/3 | — | 6 3 0 |
| do. 4½ Pref. | £5 | 4½ | 4½ | 4½ | — | 5 2 10 |
| India-Rubber | £1 | 10 | — | 13/9xd | +1/- | *7 3 4 |
| Met.-Vickers Pref. | £2 | 8 | 8 | 2 1/16 | — 1/16 | 6 11 |
| Siemens Ord. | £1 | 10 | 10 | 17/- | —6d. | Nil |
| Telegraph Con. | £13 | 20 | 20 | 24 | — ½ | *6 0 |

*Dividends paid free of Income Tax.

# ELECTRICITY IN MINING.

*(Concluded from page 889.)*

The following tables show (A) details of the electrical equipment and (B) details of coal-cutting machines and the amount of mineral cut by them. They also show the number of conveyors employed at the coal face, which increased by 110 during the year. Table (C) shows the number of electric safety lamps in use as compared with oil safety lamps, and it is satisfactory to note that the number of electric lamps is gradually being increased, whilst the number of oil lamps is gradually decreasing.

We may also note that 31,516,394 explosive shots were fired by means of electricity, nearly 10 millions more than in the previous year, and that 63,821 horses and ponies are yet employed below ground.

## PLANT AND EQUIPMENT.

Statement showing for Mines under the Coal Mines Act in Great Britain particulars for the Year 1922 of (*a*) Electrical Equipment; (*b*) Coal-cutting Machines and Mineral cut by them, and Conveyors in use at the Coal Face; (*c*) Safety Lamps in use.

| — | Northumberland, Durham Cumberland, and Westmorland. | Lancashire and Yorkshire. | Nottinghamshire and Derbyshire. | Staffordshire, Leicestershire Worcestershire and Warwickshire | Shropshire Forest of Dean, Somersetshire, Bristol and Kent. | North and South Wales. | Scotland. | Great Britain. Year 1922. | Great Britain. Year 1921; (including Ireland). |
|---|---|---|---|---|---|---|---|---|---|
| **A. ELECTRICAL EQUIPMENT.** | | | | | | | | | |
| Number of Mines at which Electrical Equipment is installed ... ... | 257 | 291 | 98 | 117 | 36 | 382 | 359 | 1,557 | 1,570 |
| Aggregate horse-power in use: Below Ground— | | | | | | | | | |
| Haulage ... ... ... | 59,876 | 43,595 | 25,312 | 23,885 | 3,875 | 72,161 | 50,392 | 283,616 | 261,358 |
| Pumping ... ... | 64,525 | 40,220 | 11,730 | 15,427 | 12,729 | 79,293 | 85,207 | 313,076 | 297,901 |
| Portable Machinery ... | 7,992 | 7,242 | 8,363 | 5,085 | 354 | 2,619 | 37,080 | 68,886 | 64,406 |
| Miscellaneous ... ... | 5,518 | 4,883 | 579 | 906 | 452 | 3,428 | 6,647 | 22,448 | 21,240 |
| Total ... | 137,911 | 95,940 | 45,974 | 45,303 | 17,410 | 157,521 | 179,326 | 688,026 | 644,905 |
| Above Ground— | | | | | | | | | |
| Winding ... ... ... | 19,937 | 9,329 | 565 | 715 | 225 | 38,005 | 5,090 | 76,248 | 62,665 |
| Ventilation ... ... | 26,732 | 17,752 | 5,360 | 2,900 | 548 | 26,440 | 8,241 | 89,207 | 84,543 |
| Haulage ... ... ... | 14,575 | 4,906 | 1,865 | 2,986 | 309 | 26,563 | 5,582 | 59,475 | 50,959 |
| Coal Washing or Screening ... ... ... | 20,098 | 26,557 | 8,420 | 5,573 | 469 | 14,511 | 11,414 | 87,746 | 83,686 |
| Miscellaneous ... ... | 56,597 | 62,019 | 17,375 | 13,525 | 1,580 | 67,382 | 19,708 | 239,472 | 221,345 |
| Total ... | 137,939 | 120,563 | 33,585 | 25,699 | 3,131 | 172,901 | 50,035 | 552,148 | 503,198 |
| Total Below and Above Ground ... ... ... | 275,850 | 216,503 | 79,559 | 71,002 | 20,541 | 330,422 | 229,361 | 1,240,174 | 1,148,103 |
| **B. COAL-CUTTING MACHINES AND THE MINERAL CUT BY THEM, AND CONVEYORS IN USE AT THE COAL FACE.** | | | | | | | | | |
| Total Number of Mines at Work ... ... ... | 427 | 595 | 185 | 327 | 145 | 686 | 513 | 2,911 | 3,045 |
| Number of Mines at which Coal-cutting Machines were in use ... ... | 132 | 178 | 48 | 66 | 11 | 94 | 256 | 785 | 776 |
| Number and Type of Machines in use— | | | | | | | | | |
| Disk ... ... ... | 101 | 282 | 60 | 26 | 4 | 16 | 724 | 1,213 | 1,247 |
| Bar ... ... ... | 83 | 138 | 83 | 20 | 3 | 71 | 397 | 795 | 724 |
| Chain ... ... ... | 226 | 312 | 249 | 257 | 5 | 211 | 219 | 1,479 | 1,317 |
| Percussive ... ... ... | 984 | 699 | 38 | 104 | 11 | 85 | 25 | 1,946 | 1,969 |
| Total No. of Machines driven by— Electricity | 281 | 275 | 289 | 185 | 12 | 93 | 1,260 | 2,395 | 2,257 |
| Total No. of Machines driven by— Compressed Air ... | 1,113 | 1,156 | 141 | 223† | 11 | 290 | 105 | 3,039† | 3,002† |
| Total Number of Machines | 1,394 | 1,431 | 430 | 408† | 23 | 383 | 1,365 | 5,434† | 5,259† |
| Tonnage of Coal cut by Coal-cutting Machines— | | | | | | | | Tons. | Tons. |
| Disk ... ... ... | 951,658 | 2,421,530 | 525,097 | 308,975 | 30,975 | 54,887 | 8,115,493 | 12,408,615 | 8,142,080 |
| Bar ... ... ... | 651,202 | 1,191,447 | 689,472 | 170,725 | 32,210 | 568,755 | 3,507,362 | 6,811,173 | 3,887,266 |
| Chain ... ... ... | 2,151,068 | 2,943,760 | 2,692,321 | 2,232,645 | 33,336 | 1,503,341 | 2,569,218 | 14,125,689 | 7,999,960 |
| Percussive ... ... | 3,281,758 | 1,085,315 | 87,919 | 148,188 | 18,792 | 113,514 | 43,039 | 4,778,525 | 9,009,790 |
| Total Quantity of Coal Cut | 7,035,686 | 7,642,052 | 3,994,809 | 2,860,653† | 115,313 | 2,240,497 | 14,235,112 | 38,124,122† | 23,039,705† |
| Percentage of Total Output Cut by Machines ... | — | — | — | — | — | — | — | 15 | 14 |
| Tonnage of other Materials Cut by Coal-cutting Machines— | | | | | | | | Tons. | Tons. |
| Ironstone ... ... ... | — | — | — | 52,034 | — | — | 60,631 | 112,665 | 140,967 |
| Fireclay ... ... ... | 50 | 12,981 | 1,315 | — | — | — | 13,730 | 28,076 | 27,252 |
| Number of Conveyors at Coal Face ... ... | 118 | 211 | 43 | 26 | 16 | 418 | 102 | 928 | 818 |
| **C. SAFETY LAMPS IN USE.** | | | | | | | | | |
| Number of Flame Safety Lamps ... ... ... | 111,689 | 178,484 | 65,838 | 69,056 | 5,392 | 126,703 | 27,017 | 584 404 | 605,566 |
| Number of Elec. Safety Lamps | 30,188 | 90,125 | 48,588 | 11,696 | 179 | 100,681 | 13,136 | 294,593 | 268,538 |
| Total Number of Lamps in use ... ... ... ... | 141,877 | 268,609 | 114,426 | 80,752 | 5,571 | 227,384 | 40,153 | 878,997 | 874,104 |

In consequence of the national stoppage of work at coal mines, almost all the mines were idle for about three months in 1921.

† Including one rotary heading machine in 1922 and two in 1921, and the quantity of mineral cut by them.

# SWISS TRADE STATISTICS.

The following statistics, showing the import and export trade of Switzerland in electrical and allied goods, have been taken from the recently-issued official trade returns relating to the year 1922. The figures for 1921 have been set beside them, and notes added of any increases or decreases.

## Imports.

| | 1921. Fr. | 1922. Fr. | Inc. or dec. Fr. |
|---|---|---|---|
| *Electric cable, not insulated.*— | | | |
| Total ... ... | 53,000 | 25,000 | – 28,000 |
| From Germany ... ... | 29,000 | 15,000 | – 14,000 |
| ,, France ... ... | 18,000 | 4,000 | – 14,000 |
| ,, United States ... | 4,000 | 3,000 | – 1,000 |
| *Electric cable not lead covered or iron armoured, and insulated wire.*— | | | |
| Total ... ... | 151,000 | 347,000 | + 196,000 |
| From Germany ... ... | 110,000 | 200,000 | + 90,000 |
| ,, United Kingdom | 1,000 | 103,000 | + 102,000 |
| ,, France ... ... | 15,000 | 6,000 | – 9,000 |
| ,, Italy ... ... | 15,000 | 3,000 | – 12,000 |
| *Cable covered with lead.*— | | | |
| Total ... ... | 32,000 | 13,000 | – 19,000 |
| From Germany ... ... | 20,000 | 6,000 | – 14,000 |
| ,, Austria ... ... | 12,000 | — | – 12,000 |
| ,, Italy ... ... | — | 4,000 | + 4,000 |
| *Cable covered with lead and iron armoured.*— | | | |
| Total ... ... | 1,170,000 | 430,000 | – 740,000 |
| From Germany ... ... | 970,000 | 214,000 | – 756,000 |
| ,, Italy ... ... | 85,000 | 1,000 | – 84,000 |
| ,, United Kingdom | 50,000 | 142,000 | + 92,000 |
| ,, France ... ... | 41,000 | 73,000 | + 32,000 |
| *Cable insulated with rubber or paper and covered with textiles.*— | | | |
| Total ... ... | 474,000 | 231,000 | – 243,000 |
| From Germany ... ... | 359,000 | 93,000 | – 266,000 |
| ,, Italy ... ... | 18,000 | 7,000 | – 11,000 |
| ,, France ... ... | 23,000 | 3,000 | – 20,000 |
| ,, Belgium ... ... | 68,000 | 127,000 | + 59,000 |
| *Cable ditto covered with lead.*— | | | |
| Total ... ... | 430,000 | 475,000 | + 45,000 |
| From Germany ... ... | 191,000 | 21,000 | – 170,000 |
| ,, Belgium ... ... | 172,000 | 43,000 | – 129,000 |
| ,, Italy ... ..... | 37,000 | 407,000 | + 370,000 |
| *Dynamo electric machines and electric transformers.*— | | | |
| Total ... ... | 2,199,000 | 1,551,000 | – 648,000 |
| From Germany ... ... | 1,733,000 | 898,000 | – 835,000 |
| ,, France ... ... | 101,000 | 66,000 | – 35,000 |
| ,, Italy ... ... | 30,000 | 8,000 | – 22,000 |
| ,, United Kingdom | 80,000 | 105,000 | + 25,000 |
| ,, United States ... | 147,000 | 411,000 | + 264,000 |
| *Accumulators, batteries, electrodes in combination with rubber or celluloid.*— | | | |
| Total ... ... | 472,000 | 745,000 | + 273,000 |
| From Germany ... ... | 243,000 | 373,000 | + 130,000 |
| ,, Italy ... ... | 16,000 | 21,000 | + 5,000 |
| ,, France ... ... | 44,000 | 144,000 | + 100,000 |
| ,, United States ... | 90,000 | 27,000 | – 63,000 |
| ,, Austria ... ... | 30,000 | 128,000 | + 98,000 |
| ,, United Kingdom | — | 36,000 | + 36,000 |
| *Accumulators, &c. (other).*— | | | |
| Total ... ... | 226,000 | 101,000 | – 125,000 |
| From Germany ... ... | 200,000 | 55,000 | – 145,000 |
| ,, France ... ... | 13,000 | 31,000 | + 18,000 |
| *Electric locomotives.*— | | | |
| Total ... ... | 11,000 | 7,000 | – 4,000 |
| *Steam engines, cranes, pumps, turbines, &c.*— | | | |
| Total ... ... | 588,000 | 412,000 | – 176,000 |
| From Germany ... ... | 464,000 | 282,000 | – 182,000 |
| ,, United Kingdom | 71,000 | 44,000 | – 27,000 |
| ,, Austria ... ... | 28,000 | — | – 28,000 |
| ,, France ... ... | 13,000 | 4,000 | – 9,000 |
| ,, United States ... | — | 81,000 | + 81,000 |
| *Electric arc lamps.*— | | | |
| Total ... ... | 15,000 | 18,000 | + 3,000 |
| From Germany ... ... | 14,000 | 17,000 | + 3,000 |
| *Electric incandescent lamps, unmounted.*— | | | |
| Total ... ... | 8,000 | 500 | – 7,500 |
| From Germany ... ... | 2,000 | 500 | – 1,500 |
| ,, France ... ... | 5,000 | — | – 5,000 |
| *Electric incandescent lamps, mounted.*— | | | |
| Total ... ... | 2,276,000 | 1,638,000 | – 638,000 |
| From Germany ... ... | 803,000 | 586,000 | – 217,000 |
| ,, Austria ... ... | 857,000 | 257,000 | – 600,000 |
| ,, Holland ... ... | 449,000 | 693,000 | + 244,000 |
| ,, United Kingdom | 3,000 | 13,000 | + 10,000 |
| ,, France ... ... | — | 40,000 | + 40,000 |
| ,, Hungary ... ... | — | 38,000 | + 38,000 |
| *Insulators, mounted.*— | 1921. Fr. | 1922. Fr. | Inc. or dec. Fr. |
| Total ... ... | 762,000 | 364,000 | – 398,000 |
| From Germany ... ... | 104,000 | 68,000 | – 36,000 |
| ,, United Kingdom | 8,000 | 4,000 | – 4,000 |
| ,, United States ... | 639,000 | 253,000 | – 386,000 |
| ,, Canada ... ... | — | 35,000 | + 35,000 |
| *Electric meters.*— | | | |
| Total ... ... | 1,937,000 | 366,000 | – 1,571,000 |
| From Germany ... ... | 1,823,000 | 331,000 | – 1,492,000 |
| ,, France ... ... | 69,000 | 17,000 | – 52,000 |
| ,, United Kingdom | 21,000 | 7,000 | – 14,000 |
| *Telegraph and telephone apparatus.*— | | | |
| Total ... ... | 2,195,000 | 3,094,000 | + 899,000 |
| From Germany ... ... | 1,514,000 | 1,800,000 | + 286,000 |
| ,, United Kingdom | 89,000 | 285,000 | + 196,000 |
| ,, Sweden ... ... | 4,000 | 4,000 | — |
| ,, France ... ... | 138,000 | 55,000 | – 83,000 |
| ,, United States ... | 43,000 | — | – 43,000 |
| ,, Belgium ... ... | 396,000 | 938,000 | + 542,000 |

## Exports.

| | | | |
|---|---|---|---|
| *Dynamo electric machines and electric transformers of all kinds.*— | | | |
| Total ... ... | 42,603,000 | 24,986,000 | – 17,617,000 |
| To Germany ... ... | 580,000 | 432,000 | – 148,000 |
| ,, Austria ... ... | 90,000 | 162,000 | + 72,000 |
| ,, France ... ... | 7,907,000 | 6,084,000 | – 1,823,000 |
| ,, Italy ... ... ... | 1,633,000 | 966,000 | – 667,000 |
| ,, Belgium ... ... | 6,012,000 | 1,657,000 | – 4,355,000 |
| ,, United Kingdom ... | 3,225,000 | 1,472,000 | – 1,753,000 |
| ,, Egypt ... ... ... | 664,000 | 755,000 | + 91,000 |
| ,, Spain ... ... ... | 5,491,000 | 3,796,000 | – 1,695,000 |
| ,, British India ... | 608,000 | 1,033,000 | + 425,000 |
| ,, Poland ... ... | 647,000 | 486,000 | – 161,000 |
| ,, Rumania ... ... | 26,000 | 629,000 | + 509,000 |
| ,, Colombia, &c ... | 55,000 | 629,000 | + 574,000 |
| ,, Brazil ... ... ... | 832,000 | 716,000 | – 116,000 |
| ,, Argentina ... ... | 764,000 | 412,000 | – 352,000 |
| ,, Netherlands ... ... | 3,604,000 | 811,000 | – 2,793,000 |
| ,, Norway ... ... | 3,230,000 | 918,000 | – 2,312,000 |
| ,, Netherlands Indies | 1,738,000 | 204,000 | – 1,534,000 |
| ,, China ... ... ... | 1,555,000 | 375,000 | – 1,180,000 |
| ,, Japan ... ... ... | 1,576,000 | 1,552,000 | – 24,000 |
| *Accumulator batteries, electrodes in combination with rubber or celluloid.*— | | | |
| Total ... ... | 17,000 | 34,000 | + 17,000 |
| To Germany ... ... | 1,000 | — | – 1,000 |
| ,, France ... ... | 2,000 | 4,000 | + 2,000 |
| ,, Italy ... ... ... | 1,000 | — | – 1,000 |
| ,, United Kingdom ... | 2,000 | 15,000 | + 13,000 |
| ,, Spain ... ... ... | 5,000 | 2,000 | – 3,000 |
| ,, Portugal ... ... | 6,000 | — | – 6,000 |
| ,, Greece ... ... | — | 3,000 | + 3,000 |
| ,, Egypt ... ... ... | — | 4,000 | + 4,000 |
| ,, United States ... | — | 3,000 | + 3,000 |
| *Accumulators, &c. (other).*— | | | |
| Total ... ... | 76,000 | 158,000 | + 82,000 |
| To France ... ... | 7,000 | 7,000 | — |
| ,, Italy ... ... ... | 5,000 | — | – 5,000 |
| ,, Egypt ... ... ... | 10,000 | — | – 10,000 |
| ,, Greece ... ... | 19,000 | — | – 19,000 |
| ,, Spain ... ... ... | 14,000 | 2,000 | – 12,000 |
| ,, Netherlands Indies ... | 7,000 | — | – 7,000 |
| ,, Rumania ... ... | — | 140,000 | + 140,000 |
| *Insulators, mounted.*— | | | |
| Total ... ... | 498,000 | 304,000 | – 194,000 |
| To Germany ... ... | 134,000 | 24,000 | – 110,000 |
| ,, France ... ... | 93,000 | 91,000 | – 2,000 |
| ,, Holland ... ... | 81,000 | 7,000 | – 74,000 |
| ,, Italy ... ... ... | 88,000 | 35,000 | – 53,000 |
| ,, Sweden ... ... | 18,000 | 21,000 | + 3,000 |
| ,, Spain ... ... ... | 39,000 | 51,000 | + 12,000 |
| ,, United Kingdom ... | 2,000 | 58,000 | + 56,000 |
| *Electric cable not insulated.*— | | | |
| Total ... ... | 58,000 | 96,000 | + 38,000 |
| To France ... ... | 3,000 | 41,000 | + 38,000 |
| ,, Belgium ... ... | 6,000 | 5,000 | – 1,000 |
| ,, Spain ... ... ... | 3,000 | 1,000 | – 2,000 |
| ,, United Kingdom ... | — | 26,000 | + 26,000 |
| ,, Rumania ... ... | — | 14,000 | + 14,000 |
| *Cable not lead covered or iron armoured, Insulated wire.*— | | | |
| Total ... ... | 995,000 | 839,000 | – 156,000 |
| To France ... ... | 373,000 | 64,000 | – 309,000 |
| ,, United Kingdom ... | 279,000 | 474,000 | + 195,000 |
| ,, Czecho Slovakia ... | 137,000 | 32,000 | – 105,000 |
| ,, Austria ... ... | 89,000 | 28,000 | – 61,000 |
| ,, India ... ... ... | 7,000 | 94,000 | + 87,000 |
| ,, Rumania ... ... | 11,000 | 73,000 | + 62,000 |

| | 1921. Fr. | 1922. Fr. | Inc. or dec. Fr. |
|---|---|---|---|
| *Cable, lead-covered.*— | | | |
| Total ... ... | 42,000 | 233,000 | + 191,000 |
| To Austria ... ... | 28,000 | — | − 28,000 |
| ,, China ... ... | 10,000 | — | − 10,000 |
| ,, Rumania ... ... | — | 227,000 | + 227,000 |
| *Cable, lead-covered and iron armoured.*— | | | |
| Total ... ... | 261,000 | 508,000 | + 247,000 |
| To Greece ... ... | 81,000 | — | − 81,000 |
| ,, Turkey ... ... | 64,000 | — | − 64,000 |
| ,, Poland ... ... | 52,000 | — | − 52,000 |
| ,, Rumania ... ... | — | 494,000 | + 494,000 |
| ,, Brazil ... ... | — | 10,000 | − 10,000 |
| *Cable, insulated with rubber or paper and covered with textiles.*— | | | |
| Total ... ... | 594,000 | 12,000 | − 582,000 |
| To France ... ... | 15,000 | 10,000 | − 5,000 |
| ,, Portugal ... ... | 69,000 | — | − 69,000 |
| *Electric locomotives.*— | | | |
| Total ... ... | 420,000 | 32,000 | − 388,000 |
| To Sweden ... ... | 85,000 | 15,000 | − 70,000 |
| ,, Brazil ... ... | 219,000 | — | − 219,000 |
| ,, Holland ... ... | — | 12,000 | + 12,000 |
| *Telegraph and telephone apparatus.*— | | | |
| Total ... ... | 201,000 | 1,667,000 | + 1,406,000 |
| To France ... ... | 25,000 | 13,000 | − 12,000 |
| ,, Italy ... ... ... | 49,000 | 20,000 | − 29,000 |
| ,, Holland ... ... | 17,000 | 3,000 | − 14,000 |
| ,, Spain ... ... ... | 8,000 | 1,000 | − 7,000 |
| ,, Belgium ... ... | 49,000 | 18,000 | − 31,000 |
| ,, Rumania ... ... | — | 1,589,000 | + 1,589,000 |
| *Electric incandescent lamps, mounted.*— | | | |
| Total ... ... | 4,564,000 | 3,868,000 | − 696,000 |
| To Austria ... ... | 760,000 | 51,000 | − 709,000 |
| ,, France ... ... | 312,000 | 845,000 | + 533,000 |
| ,, Italy ... ... ... | 2,512,000 | 1,792,000 | − 720,000 |
| ,, Portugal ... ... | 58,000 | 74,000 | + 16,000 |
| ,, Spain ... ... ... | 21,000 | 22,000 | + 1,000 |
| ,, Greece ... ... | 57,000 | 25,000 | − 32,000 |
| ,, Norway ... ... | 64,000 | 229,000 | + 165,000 |
| ,, Rumania ... ... | 85,000 | 91,000 | + 6,000 |
| ,, Algeria ... ... | 16,000 | 102,000 | + 86,000 |
| ,, Canada ... ... | 51,000 | 140,000 | + 89,000 |
| ,, Australia ... ... | 4,000 | 88,000 | + 84,000 |
| ,, Czecho Slovakia ... | — | 126,000 | + 126,000 |
| ,, British India ... | 99,000 | 8,000 | − 91,000 |
| ,, United Kingdom ... | 149,000 | 76,000 | − 73,000 |
| ,, Egypt ... ... ... | 115,000 | 18,000 | − 97,000 |
| *Electric incandescent lamps, unmounted.*— | | | |
| Total ... ... | 4,000 | 1,000 | − 3,000 |
| To France ... ... | 2,000 | 1,000 | − 1,000 |
| ,, Austria ... ... | 2,000 | — | − 2,000 |
| *Electricity meters.*— | | | |
| Total ... ... | 8,925,000 | 8,067,000 | − 858,000 |
| To Germany ... ... | 35,000 | 28,000 | − 7,000 |
| ,, Austria ... ... | 36,000 | 18,000 | − 18,000 |
| ,, France ... ... | 1,825,000 | 2,043,000 | + 218,000 |
| ,, Italy ... ... ... | 861,000 | 608,000 | − 253,000 |
| ,, United Kingdom ... | 1,591,000 | 687,000 | − 904,000 |
| ,, Belgium ... ... | 1,728,000 | 1,236,000 | − 492,000 |
| ,, Spain ... ... ... | 378,000 | 594,000 | + 216,000 |
| ,, Japan ... ... ... | 359,000 | 897,000 | + 538,000 |
| ,, Netherlands ... ... | 222,000 | 341,000 | + 119,000 |
| ,, Czecho-Slovakia ... | 776,000 | 668,000 | − 108,000 |
| ,, Australia ... ... | 338,000 | 378,000 | + 40,000 |
| *Steam engines, cranes, pumps, turbines, &c.*— | | | |
| Total ... ... | 22,151,000 | 16,829,000 | − 5,322,000 |
| To Germany ... ... | 825,000 | 311,000 | − 514,000 |
| ,, France ... ... | 3,670,000 | 3,144,000 | − 526,000 |
| ,, Belgium ... ... | 4,270,000 | 2,956,000 | − 1,314,000 |
| ,, Holland ... ... | 2,464,000 | 1,281,000 | − 1,183,000 |
| ,, British India ... | 352,000 | 4,000 | − 348,000 |
| ,, Japan ... ... ... | 2,962,000 | 1,581,000 | − 1,381,000 |
| ,, United Kingdom ... | 2,695,000 | 2,922,000 | + 227,000 |
| ,, Spain ... ... ... | 751,000 | 197,000 | − 554,000 |
| ,, China ... ... ... | 1,360,000 | 284,000 | − 1,076,000 |
| ,, Argentina ... ... | 895,000 | 1,200,000 | + 305,000 |
| ,, Egypt ... ... ... | 184,000 | 247,000 | + 63,000 |
| ,, Rumania ... ... | 176,000 | 130,000 | − 46,000 |
| ,, Russia ... ... | 7,000 | 383,000 | + 376,000 |
| ,, Portugal ... ... | 104,000 | 291,000 | + 187,000 |
| ,, Colombia, &c. ... | — | 207,000 | + 207,000 |

**The United States Electrical Industry.**—A very encouraging picture is presented in a recent survey of conditions in the electrical industry of the United States by the *Electrical World*. Many branches, including motors, portable lamps, switchgear, and insulators are said to be working at full pressure to meet the demand. The electrical exports during October were valued at $6,035,410, as compared with $5,123,290 in October, 1922.

## AIRCRAFT LEADER CABLE SYSTEMS.

### The Electrical Steering of Aeroplanes.

MEMBERS of the Institution of Aeronautical Engineers recently listened to a paper, written by Mr. William Loth, of Paris, on the subject of leader cable systems for the electrical steering of aeroplanes, which was read by Mr. John Gray, B.Sc., M.I.E.E., the object being to draw attention to a matter which does not appear to have attracted the notice that its importance warrants. Fundamentally an old idea is used, namely, that of guiding a ship by means of suitable apparatus on board, whereby the electric current in a cable laid, for example, in a harbour, can be detected so that the ship may be safely steered into port.

So far as the author is aware, no attempts, other than his own, have been made to apply this method for the purpose of steering aircraft; he has given the subject his attention over a period of ten years, and has studied experimentally and mathematically the shape of the magnetic field of the loop comprising the insulated conductor and the earth or water return, the insulated part of the loop being fed with a high-frequency alternating current. He has made thousands of measurements for determining the shapes of the magnetic fields and has found as a result of his experiments, which in the air have been carried out at distances as great as 15 km. from the cable, that the field is not a simple magnetic one, but a resulting field formed by three elementary magnetic fields:—

1. Magnetic field due to the current circulating in the cable (the least important for guiding purposes); (2) magnetic field due to the return current in the ground or the sea; (3) field due to the currents induced in the conducting mass surrounding the loop.

For the secure navigation of aircraft along a route traced by a guide cable it is necessary to know at every instant on aircraft: (i) the direction of the route and the perpendicular to this route, by two different and independent operations, so as to check them one by the other; (ii) the inclination of the aircraft on the route to be followed determined by the guide cable (that is to say, the angle formed by the great axis of the movable object, or its axis of route, with the direction of the guide cable at the point where the movable object is located; (iii) the direction of this inclination (inclination of the aircraft towards the right or towards the left); (iv) the number of degrees of this inclination, if possible; (v) the side of the guide cable on which the aircraft is located; (vi) the distance separating the aircraft from the guide cable; (vii) the horizontal plane of flight; and (viii) if the guide cable on land is ascending or descending.

The apparatus used consists of three vertical coils—one parallel to the axis of the aircraft, another at right angles to this axis, and the third a horizontal coil. All the coils are embodied in the fuselage structure of an aeroplane, for example, and their ends are connected to a switching arrangement whereby various combinations of connection between the coils can be made. The current induced in the coils is detected by means of suitable amplifiers and a telephone, as is done in radio-telegraphy. The direction of the guide line and the perpendicular to the direction of the guide line are obtained by observing the current in the two vertical coils, one of which is parallel to the axis of the aircraft and the other at right angles to the aircraft. The inclination and the direction of the inclination of the axis of the aircraft to the direction of the guide line are obtained by connecting these two coils successively in series, reversing the terminals at each connection. By observing the amount of current induced in the coils in each connection, the inclination (whether towards the right or the left) can be ascertained. The number of degrees of inclination may be ascertained by using the well-known radiogoniometric method of measuring the relative values of the currents, but such a device considerably interferes with reception and can only be used on a few hundred metres of the guide line.

The drift of the aircraft from left to right or from right to left of the guide line is ascertained by connecting in series, in the manner indicated above, the longitudinal vertical and the horizontal coils. The inclination of the guide line is ascertained by connecting in series the horizontal and transverse vertical coils. In the trials which have been made alternating current is supplied to the insulated cable at a frequency of from 3,000 to 5,000 periods per second. Emergency aerodromes may be provided at suitable distances from each other on the guide line and may be brought to the attention of pilots by supplying them from local lines with current at a frequency of, say, 50,000 periods per second.

It will thus be appreciated that by very simple apparatus a pilot can determine his route under all weather conditions and in darkness and, if his landing station is equipped with a suitable electrified line, he is assured of a safe landing under all conditions.

The French Government has taken a keen interest in the invention, and has afforded every facility for its trial. Several guide lines have been projected and some already installed, one from Paris to Boulogne, with the object of linking through an under-channel cable with guiding lines placed overground in this country.

# CHINA'S DELAYED DEVELOPMENT.

**Difficulties of British Merchants.**

On the whole the report by the British Commercial Secretary at Shanghai, Mr. H. J. Brett, on the trade of China up to June, 1923, is a gloomy document. This will not surprise those who have knowledge of the grave disorder that bars the way to the further progress of commerce and industry in that vast and comparatively undeveloped land.

Few British traders in China have been able to show a profit on their year's work, whilst many have suffered heavy losses. This adversity has been shared by all foreign merchants, and it is at least satisfactory to find that Great Britain's share of China's trade is being fairly well maintained.

One of the worst phases of the general situation is the deplorable condition of the railways. As the outstanding indebtedness to foreign firms of the Peking authorities is considerably in excess of $60,000,000, there is no inducement to British or other constructors to interest themselves further in extensions or renewals. Trunk lines, such as the Hankow-Canton railway, which was commenced 18 years ago, are still unfinished. Traffic has been constantly interrupted, more particularly in the north, and the wholesale commandeering of wagons has led to a general shortage of transport facilities on all main lines, to the serious detriment of China's export trade. Management, says the Commercial Secretary, is inefficient and corrupt.

Yet Mr. Brett finds some encouragement. It must be recognised, he says, that the development of those centres where the existence of foreign settlements offers some guarantee of security, continues unabated. There is evidence of confidence in Shanghai and other ports where, during the past few years, mills, factories, and handsome offices have been erected in spite of disturbances in the interior.

**Industrial Activity.**

As evidence of the continued increase of industrial activity in Shanghai, the Commercial Secretary quotes the figures published by the Municipal Council of the international settlement, showing the consumption of electricity supplied by the municipal power plant. This amounted in 1922 to 232,457,361 kWh. Of the total energy sold, 200,221,968 kWh was for power and heating purposes. This figure shows an increase of 44,000,000 kWh over the total for 1921, in spite of the depression affecting certain local industries during the past year.

The report states that the shipbuilding companies in Shanghai are confident of further success when general conditions improve, but that cotton spinning, after its extraordinarily rapid development, is likely to experience a setback. The silk filatures have had a busy and profitable year.

It is not surprising to learn that there have been no very striking developments in the form of new industrial enterprises. Flour-milling and match-making continue to grow, as also does sugar-refining. Beet factories have been established in Manchuria, and during the year a large refining plant was being erected in Shanghai. New cement works have been started, notably in Shanghai and Liaoyang, whilst soap-making, tanning, knitting factories, canneries, paper mills, and carpet factories are other industries in which native companies are engaging in increasing numbers.

In short, the industrialisation of China on modern lines is proceeding steadily in spite of the obstacles created by the absence of any ordered Government in the country.

**Trade-Mark Confusion.**

The report draws attention to the unsatisfactory position in relation to trade marks. A draft law has been submitted to the British Minister for consideration by the Chinese Government and the Diplomatic Body in Peking. Meanwhile, an attempt has been made by the Chinese Government to deal independently with the question of trade-mark registration by establishing bureaux at Shanghai and other ports where such marks can be registered. These facilities, the report points out, constitute no real evidence of proprietorship nor ensure legal protection against infringement.

**Machine Tools.**

In spite of the adverse conditions in China at the present time, there is, according to the report, a fairly steady demand for machine tools; lathes of all types, from the smallest bench lathes to those required for turning 6-ft. railway wheels, a wide range of radial drilling machines, punching and shearing machines, and woodworking machines of all types being most in demand. The rapid increase in the number of mills and factories, together with extensions to those already existing, calls for a corresponding increase in the machine shops which keep this plant in running order. The railways particularly are beginning to appreciate the necessity of having up-to-date machine shops capable of dealing efficiently with repairs to rolling stock. Although the price of German tools is having its effects upon the market for light and comparatively out-of-date machines, the British manufacturer can compete favourably in most cases where modern tools are required, and in the case of the heavy machines practically monopolises the market.

**Electrical Trade.**

The electrical trade in China has steadily advanced during the past 12 months, not only in the number of new stations, and extensions to existing ones, that have been installed, but also in the type of machinery which Chinese buyers now insist upon. The education of the Chinese merchant in the matter of purchasing machinery has made considerable progress, and economy and reliability are factors entering into machinery transactions as well as the matter of price, which, a few years ago, was the only desideratum with the majority of Chinese buyers. Among the more important extensions to power plants made in the period under review, the following may be mentioned:—Hangchow (4,000 kW), Chinkiang (750 kW), Canton (5,000 kW), Hankow (6,000 kW), Changsha (2,000 kW), Yangchow (1,000 kW), Mukden (3,000 kW), Pootung (500 kW), and Pengpu (300 kW). Additions to the Peking tramway system comprise power plant, sub-station equipment, rolling stock, &c.

The foregoing are purely Chinese concerns. Among "foreign" electricity enterprises, important plant extensions have been made to the power stations at Shanghai, Kowloon, and Hong-Hong. Sufficient has been said to support the statement frequently made that in spite of political troubles and trade depression, steady progress has been made in the use of electricity, justifying the optimistic hopes that have always existed.

**Radio-Telegraphy and Telephony.**

The only advance in radio-telegraphy recorded by the Commercial Secretary during the year 1922 was the completion of the installation of a station at Urumchi, one of the chain of stations connecting Peking with Kashgar. It is reported that the Kashgar station has just been installed also, so that the chain is now complete. Attempts have been made by an American company to introduce broadcasting at Shanghai, but so far these efforts have not passed the stage of experiment and demonstration. Difficulties have been encountered owing to the refusal of the authorities to permit the importation of receiving sets pending the issue of new regulations, and for the time being the scheme appears to be in abeyance. As regards radio communication with other countries, no progress is to be recorded, chiefly owing to international difficulties between the various companies interested in the question.

Some further interesting details regarding the establishment of communication with Kashgar are given in an appendix by H.M. Consul-General in Chinese Turkestan. The constructing engineer there received messages from Tashkend, Urumchi, Rangoon, Colombo, Nauen (Hanover), Leafield, Paris, and several other stations. The stations at Urumchi and Kashgar, together with that erected at Urga, have been constructed at a cost of £180,000, and consist of 25-kilowatt Marconi arc installations, working on a 4,000-metre wave and having an effective range of 1,000 miles. It is difficult to see, says the Consul-General, what prospect of success there is before the Kashgar and Urumchi stations from the commercial point of view; at least 1,000 messages a month would be required before either of them would begin to pay, whereas the entire commercial and official traffic from Kashgar to India and China combined would not be likely even to approach that figure.

**Marketing Methods.**

With regard to the question as to the best method of marketing British goods in China, the Commercial Secretary finds no reason to modify the opinion so frequently expressed in previous reports that the British merchant firms established in that country afford the British manufacturer the safest and most satisfactory medium of communication with the market. This remark does not, of course, apply to the case of manufacturers who are prepared to maintain their own selling organisations in China, as has been done so successfully in the case of the companies selling kerosene, cigarettes, alkalis, sugar, &c., but to those who, whilst desirous of finding a market for their goods in that country, are not disposed to venture a large amount of capital in establishing themselves in business there on their own account. Direct trading between the native merchant in China and the manufacturer or shipper in foreign countries is still beset with difficulties, and although the number of Chinese firms competent to establish direct relations with houses abroad is gradually increasing, great care is necessary in any transactions other than those on a strictly cash basis. When merchants in China, with all their experience of local conditions, are finding the utmost difficulty in securing the fulfilment of their contracts, it is clear that firms in a foreign country who enter into credit transactions with native concerns in that country are taking a very serious risk. Mr. Brett repeats the advice tendered in previous reports to firms contemplating business with China as to the advisability of sending out a representative to study the market. Much more can be effected by such a personal visit, both in acquiring knowledge of local conditions and in forming business connections, than can possibly be brought about by correspondence.

# THE METROPOLITAN-VICKERS STEAM TURBINE.

**A Description of an 18,750-kW Turbine, as built for the Dalmarnock Power Station (Glasgow).**

The problems which arise in the design and construction of steam turbines for modern economical steam conditions are those which are incidental to increased pressure, the behaviour and expansion of metals exposed to high temperatures, and the even distribution of temperatures over large masses of metal.

These problems are of special importance in the case of the larger units, and they have been dealt with by the Metropolitan-Vickers Electrical Co., Ltd., by means of improvements in design and construction which have as their object the most reliable and economical operation of steam turbines under the high steam pressures and temperatures that are commercially possible.

In fig. 1, which is a longitudinal section of the company's 18,750-kW turbine, it will be seen that the high-pressure end A, being a separate portion bolted vertically, can be, where the conditions justify it, made of cast steel, as also can the diaphragms contained in this portion. Another interesting feature is the internal-type nozzle boxes B, made in the shape of pipes. These are bolted at one end to the steam-chest or to a pipe connecting the nozzle-box to the steam-chest; the other end of the nozzle-box is free to expand independently of the turbine casing, this movement being suitably guided. All joints are of a simple circular shape of relatively small dimensions, which can be kept steam tight without difficulty.

Equally important in design is the low-pressure end of the large turbine. The progress made in the construction of large and efficient turbines for working under high vacua is almost entirely dependent on the development of a suitable exhaust end, the controlling feature being the permissible length of the blades of the last stages, which is controlled by the factor of safety that is adopted. This permissible blade length is such that an increase in output beyond a certain range becomes impossible, due to the high leaving losses

To meet this difficulty the Metropolitan-Vickers Co. has developed and adopted the radial stream line and multiple exhaust, the main features of this innovation being as follows: The steam, after passing through the successive stages in the usual way, reaches the special diaphragm C; at this point the steam is divided into two parts by the ring D in the diaphragm. The steam passing through the outer annulus E is expanded to condenser pressure. In the inner annulus F the steam passes, without expansion through suitable-formed guide blades. Opposite F are the inner portions of the moving blades G suitably proportioned to again pass the steam without appreciable expansion. It then reaches the diaphragm H, where the steam is expanded finally to the full length of blade I to condenser pressure. This arrangement enables large outputs at high speeds to be obtained without the use of blades of excessive length or disks of large diameter involving high stresses.

A further advantage of the radial guidance of the steam from the turbine blades to the condenser over short and easy streamline paths is that it ensures the elimination of eddies and the uniform distribution of the steam over the whole length of the condenser tubes.

From fig. 2, showing the type of steam-chest used in connection with large turbines, it will be seen that the body of the chest consists of two pipes, an inner and an outer pipe. The inner pipe, to which steam is supplied from the main stop-valve, is provided with three valves, which admit steam to three compartments formed within the steam belt between the inner and outer pipes. Each of the compartments in turn communicates with a group of nozzles. This design provides a very compact arrangement, and the steel castings are of simple shape.

The valve-operating mechanism is arranged in such a manner that the forces are acting in one plane, and the parts which are subject to wear are removed as far as possible from those parts which are subjected to high temperatures. Referring to fig. 2, it will be seen that the three governor valves are actuated by means of oil pressure under the control of relay mechanism fitted to governor valve No. 1. As the load exceeds that which valve No. 1 is designed to carry when fully open, the spindle of this valve continues to move upwards, carrying with it a lever pivoted at one end and attached to the other end by means of a short vertical adjustable link to one end of a second lever, the other end of which is pivoted at a fixed point of governor valve No. 3. This lever moves in the same plane as the lever situated above valve No. 1, and carries with it a floating lever, which is connected at its extremities to governor valves 2 and 3. The springs which close valves 2 and 3 are so adjusted that for an increasing load valve No. 3 remains closed until valve No. 2 is fully opened, and for a decreasing load valve No. 2 does not begin to close on a decrease in load until valve No. 3 is fully closed.

In fig. 1 it will be seen that the feed-water heater J is made integral with the main turbine. This device, it is claimed, represents a substantial advance on previous practice. It is always desirable that the method of feed heating adopted should be such that low-temperature steam should be used, the maximum amount of mechanical power having been obtained from the steam prior to its utilisation for feed heating, and, as is seen in fig. 1, this result has been accomplished. Two further important advantages have also been obtained: first, the heating steam is expanded down to the

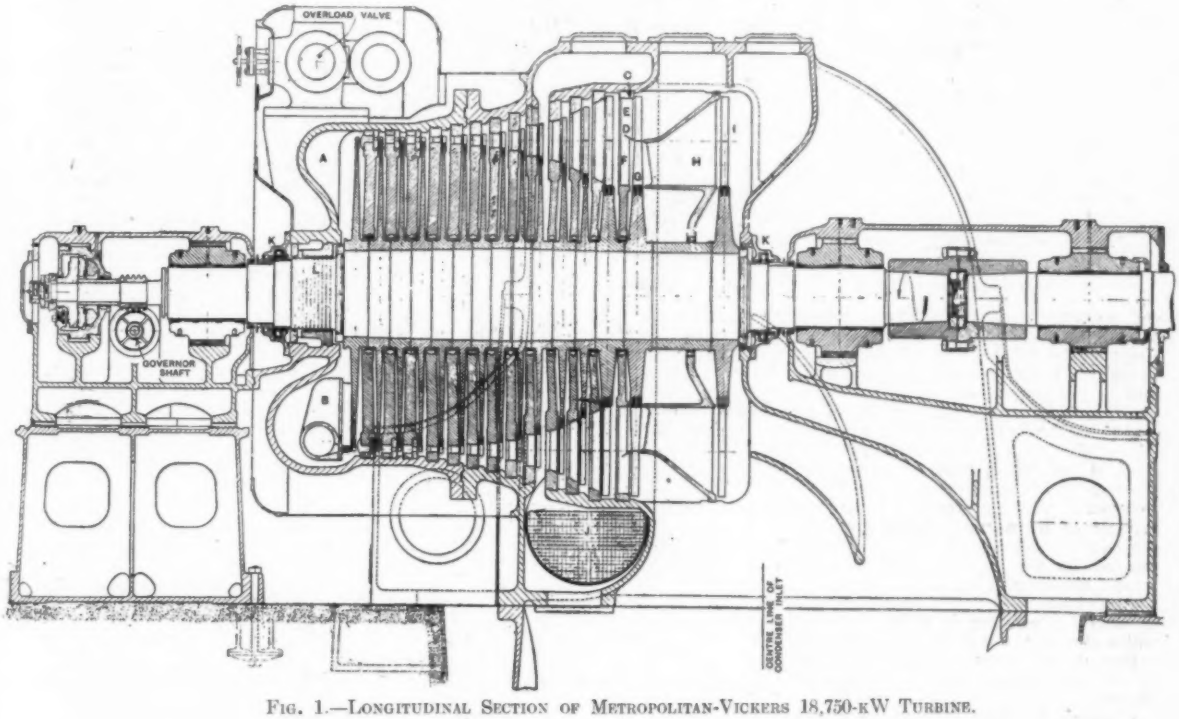


Fig. 1.—Longitudinal Section of Metropolitan-Vickers 18,750-kW Turbine.

lowest possible temperature and pressure, the feed heater being conected to the condenser; and secondly, radiation and steam leakage losses are reduced to a minimum. This form of feed-water heating enables an improvement in thermal efficiency, amounting in some cases to 5 per cent. or more, to be obtained, with a corresponding improvement in coal consumption. In the case of all the larger units the heater is arranged in two portions, consisting of a main heater, as shown in fig. 1, in which steam diverted from the turbine is utilised and a subsidiary heater, in which the gland leakage steam is used.

Fig. 3 shows a cross-section through the main governor and rotary oil pump. The governor here illustrated is specially designed to respond quickly to small variations in the speed of the turbine. The parts are simple and robust, both as regards design and construction, practically no stress being thrown upon the pins or points about which movement takes place, since the centrifugal force of the weights is opposed by the springs without the intervention of links or joints.

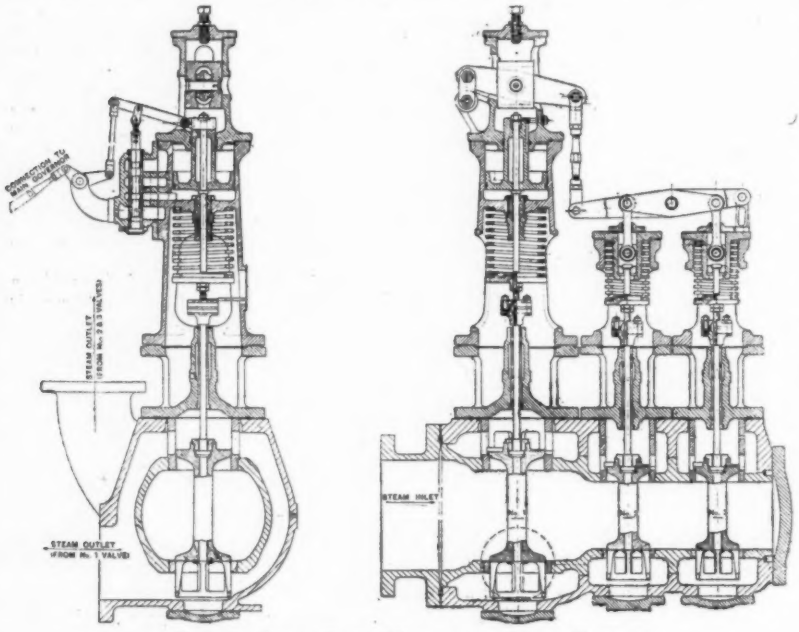


FIG. 2.—STEAM CHEST USED WITH LARGE TURBINES.

The lubrication of the complete set is carried out automatically, the oil being delivered under pressure to all the main bearings and to the various parts of the governor. The necessary pressure is maintained by a small pump A of the geared-rotary type, which is direct-coupled to the end of the governor spindle as shown in fig. 3. The oil passes through inspection boxes B to an oil tank in which a strainer is fitted, through which the oil is drawn by the pump; it is then delivered through the oil coolers to the bearings, whence it returns by gravity.

The main bearings, fig. 1, are made of cast-steel and each is in halves. They are lined with high-quality white metal. At each side and on the top and bottom pads of steel are placed, under which liners of varying thicknesses can be inserted, by means of which the main spindle can be moved in any direction for lining up or taking up wear.

As the end thrust in impulse turbines is of a comparatively small order, the function of the thrust-block can be considered as mainly that of serving to register correctly the axial position of the shaft. The thrust-block, as shown in fig. 1, is of the Michell type.

As it is essential with a steam turbine for as high a vacuum to be obtained as is commercially possible for given working conditions, it is necessary to preclude the leakage of air into the turbine. In fig. 1 are shown standard water-sealed glands K, as fitted by the Metropolitan-Vickers Electrical Co., Ltd. These provide an absolutely air-tight seal between the inside and outside of the turbine cylinder under all conditions of load and vacuum.

At the h.p. end, in addition to the water-seal, will be seen a labyrinth gland L interposed between the chambers in front of the first wheel. The leakage past the labyrinth packing is very small indeed and is led to the subsidiary heater. Important advantages of these water-sealed glands, in addition to their being absolutely air-tight, are that no heating of the bearings takes place (due to steam leakage in the direction of the bearings), that no steam or water escapes into the engine-room, and that the conditions of operation are not upset by change of steam pressure or vacuum, as is the case with steam-packed glands.

The subdivision of the exhaust end blading of the turbine, which was described in a paper read before the Institution of Electrical Engineers by Mr. K. Baumann two years ago (ELEC. REV., April 15th and 22nd, 1921), was a new departure, and was adversely criticised at the time. It appears, however, from test data recently published relating to the Metropolitan-Vickers turbines installed at the Dalmarnock power station of Glasgow Corporation, by Mr. R. B. Mitchell, that remarkably good results have been attained.

These sets were of the type and size described above, having a maximum continuous rating of 18,750 kW, a most economical rating of 15,000 kW, and generating at 6,500 volts, 25 cycles, 1,500 r.p.m.

The alternators were connected to transformers raising the pressure to 20,000 volts.

A test was made on the first set supplied by the Metropolitan-Vickers Co. (known as "No. 2") on September 19th last.

The steam conditions were: Pressure, 250 lb. per sq. in. gauge; temperature, 650 deg. F.; vacuum 29.1 in. Hg. (barometer 30 in. Hg.).

The guaranteed steam consumption for power measured after transformation was 10.44 lb. per kWh, an average being calculated as follows: Three times the consumption at maximum continuous rating (10.32 lb./kWh); five times the consumption at economical rating (10.32 lb./kWh); and twice the consumption at 75 per cent. of economical rating (10.92 lb./kWh), the average being obtained by dividing the sum of the above by 10.

The set was put into commission on August 31st, 1920, and up to the time when the tests were made had run 17,908 hours, having generated 204,559,800 kWh in that time. The results of the tests are given on p. 955.

The condenser was fouled to some extent by the vegetable matter brought down the Clyde at that time of the year, and was not cleaned before the tests were made.

The electrical instruments used were calibrated at the Manchester School of Technology, the thermometers were calibrated at the National Physical Laboratory, and the steam gauges were calibrated by a dead-weight tester.

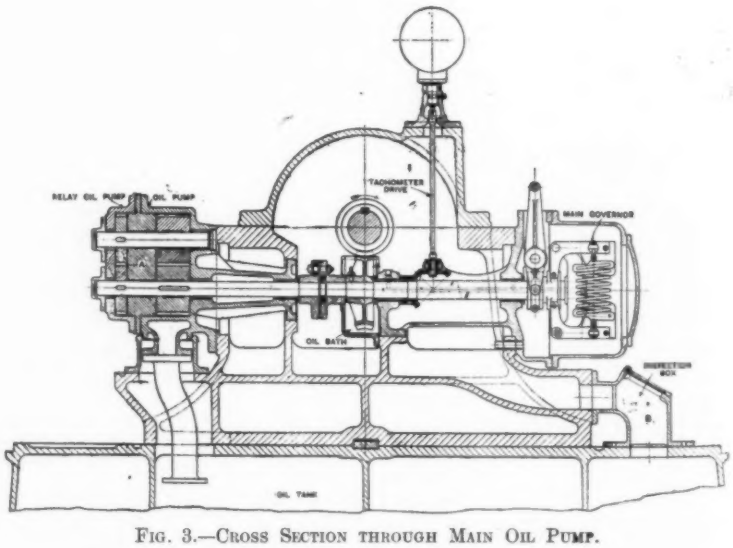


FIG. 3.—CROSS SECTION THROUGH MAIN OIL PUMP.

The results showed the No. 2 machine to have a slightly higher efficiency than No. 3 set. This was consistent with the results deduced from the general station performance.

"No. 3" set had been previously tested (on January 11th and 12th, 1923) and gave an average result, weighted in accordance with the method described above, of 10.355 lb. per kWh; the vacuum on that occasion was extraordinarily high, namely, 29.31 in., or 97.7 per cent. of the barometer reading, during the run at the most economical load, the consumption

corrected to design conditions, and with power measured at the alternator terminals being 10.207 lb./kWh. The effect of the vacuum being 0.21 in. higher than that for which the turbine was designed was that the absolute pressure at the h.p. end of the turbine was only three-quarters of the designed pressure—that is, the specific volume of the steam to be dealt with was some 30 per cent. greater than that for which the turbine was designed. If the efficiency of the Baumann exhaust stage were not as high as that of the other stages in the l.p. end, it is obvious that the difference would make itself evident under these exceptional conditions. The excellence of the results obtained in these circumstances, therefore, is held to prove that the efficiency of the multi-stage exhaust is not less than 80 per cent. even with this high vacuum.

| | | | |
|---|---|---|---|
| Nominal load—kW. ... ... ... | 18,750 | 15,000 | 11 250 |
| Duration of test—hrs. ... ... ... | 1·194 | 1·543 | 1·178 |
| Approx. load at alternator terminals—kW. | 19,000 | 16,400 | 12,500 |
| Actual conditions : | | | |
| Stop-valve press. lb./sq. in. gauge ... | 258·2 | 257·4 | 257·0 |
| Stop-valve temp degs. F. ... ... | 712 | 711 | 698 |
| Vac. 30" Bar.—inches Hg. ... ... | 28·71 | 28·89 | 29·02 |
| Consumption as run—lb./kWh (power measured at alternator terminals)... | 9·783 | 9·745 | 9·982 |
| Consumption corrected to design conditions (power measured at alternator terminals) ... ... ... ... | 9·903 | 10·00 | 10·235 |
| Consumption corrected to design conditions (power measured at h.p. side of transf.) ... ... ... ... | 10·00 | 10·086 | 10·317 |
| Average consumption—lb./kWh ... | | 10·106 | |

Both turbo-generators easily fulfilled the guaranteed figure of 10.44 lb. average consumption, which, it will be remembered, includes the transformer losses in addition to those of the turbine and alternator. Taking the turbo-generator alone, the remarkable figure of 9,745 lb. per kWh at the alternator terminals was recorded (see table above) by "No. 2" set. Moreover, the sets were tested after they had been in service for three years, and for 14 months respectively, and the results obtained indicate that there cannot have been any appreciable deterioration in their efficiency.

## THE FARADAY SOCIETY.

### The Electrodeposition of Manganese.

A group of papers read before the Society on November 12th included one on this subject by Prof. A. J. Allmand and Mr. A. N. Campbell. In the past very little work has been done on the deposition of manganese from aqueous solution, the difficulty in depositing it being due to its highly electropositive character. Grube claims to have deposited coherent metal sheet from the chloride solution, but the present authors did not succeed in obtaining such a result. Their experiments were made chiefly with sulphate and chloride solutions, and in all cases a platinum anode was used and an aluminium cathode. In the later experiments this was in the form of a rod, to which a glass fin was attached, so that when rotated it acted as a stirrer. Varying conditions of acidity of solution, current density, temperature, and type of cell were tried. The best results were obtained in a cell through which there was a rapid flow of electrolyte entering at the cathode and leaving at the anode. In a typical experiment with manganous sulphate solution of initial acidity 0.1N, temperature 8 deg. C., and a current density of 10 amps. per sq. dcm., a 100 per cent. pure metal was produced at 56.5 per cent. current efficiency, but the production of heavy, coherent manganese deposits was not attained. Interesting results were obtained on the addition of ammonium sulphate to the electrolyte, the action of which is to suppress the ionisation of ammonium hydroxide, and under some conditions pure crystalline deposits were yielded, but the current efficiency did not exceed 40 per cent. There were marked differences between the deposits from sulphate and chloride solutions. Many experiments were made in adding various addition agents and in trying other electrolytes, but no improvements were noted. It is a matter of common knowledge that the simultaneous evolution of large amounts of hydrogen renders it very difficult to get good cathodic deposits of any metal, the supposed reason being the strains caused in the electro-deposited layers by the presence of the hydrogen. The depolarisers successful in the case of nickel, such as hydrogen peroxide, potassium chlorate, nitro-benzene and cinnamic acid were tried in the case of manganese, but with negative results. If this metal could be successfully deposited it might well prove to have useful industrial applications, and it is to be hoped that the authors' continued experiments will lead to that end.

### The Cathodic Behaviour of Nickel-Iron Alloys.

This was the title of the first section of an experimental study being made by Dr. S. Glasstone, at University College, Exeter, on the cathodic behaviour of alloys generally, with the intent to throw light on the problem of over-voltage and allied phenomena. (Over-voltage is the excess potential required for the visible separation of hydrogen at a cathode over that required in the case of a platinised plate.)

In these experiments the alloys were deposited electrolytically from solutions containing salts of both metals in varying proportions, and three lines of approach were adopted: (1) to measure the cathodic potential during deposition; (2) to determine the potential required for hydrogen liberation from the various alloys used as cathodes in sulphuric acid and caustic soda solutions (*i.e.*, the overvoltage); and (3) to investigate the action of depolarisers. The iron-nickel alloys were deposited on a definite area of lead sheet from mixed ferrous and nickel sulphate solutions in which the total concentration of metal was kept constant at two equivalents per litre, the acidity also being kept constant. The anode was carbon; the temperature of the bath was kept constant at 18 deg. C. The accompanying curves (fig. 1) give the results of the first series of experiments for the particular current density of 0.12 amp. per sq. cm., and it will be seen from curve B that the deposition potential—which was −1.1 volts in the case of pure nickel and −0.95 in the case of pure iron—fell to a minimum of −0.7 with an alloy containing about 53 atomic per cent. iron. It will also be observed, from curve A, that the deposits contain relatively more iron than do the solutions from which they were deposited. The mixtures are deposited at less negative potentials because, in the mixed iron-nickel crystals, the free energy of each metal is less than in the pure state. This diminishes the solution-pressure, and so a less negative potential is required for deposition. On the other hand, we should expect that when the electrolyte contains excess of iron the solid solution deposited should contain relatively more nickel, since the concentration of nickel in the solid is less than that of iron and so its deposition potential should be depressed. This is not, however, what occurs, and the author explains the anomaly as due either to nickel acting as a positive catalyst and accelerating the reaction $Fe^{\cdot\cdot} + 2\theta \rightarrow Fe$ or iron as an inert substance or as a negative catalyst retarding the reaction $Ni^{\cdot\cdot} + 2\theta \rightarrow Fe$. Another explanation ascribes the retardation to the negative catalytic action of absorbed hydrogen.

The next measurements made were those of over-voltage, and fig. 2 records the results for the different alloys obtained in both acid and alkaline solutions in the case of a current density of 0.12 amp. per sq. cm. It will be seen that hydrogen evolution takes place at nickel-iron electrodes at much lower potentials than at either pure iron or nickel electrodes. A complete explanation of this curious effect can only be based on a generally-accepted theory of over-voltage. The results simply show that the presence of iron and nickel together prevents the accumulation of the hydrogen charge which is the immediate cause of over-voltage.

Finally the cathodic behaviour of the alloys was studied in the presence of various depolarisers, the reduction efficiencies of the various electrodes in the presence of these depolarisers being measured at definite current densities. Space will not permit of a discussion of these measurements, but they show the reduction efficiency of a particular electrode to be not altogether dependent upon the hydrogen over-voltage; the electrode itself may exert a catalytic effect. In the case of the reduction of potassium chlorate, either iron is a positive catalyst or nickel is a negative catalyst. With alkaline benzaldehyde as depolariser nickel is a positive catalyst, since the percentage of hydrogen available for reduction purposes at this electrode is greater than at one of iron which has a higher over-voltlage; further, the alloys with their low over-voltage are as efficient as iron, due no doubt to the catalytic effect of the nickel. For the reduction of alkaline nitrobenzene iron is a powerful positive catalyst, since the alloys are very much better for reduction purposes than is nickel with its much higher over-voltage. All the electrodes appear to be equally efficient in the reduction of acid nitrobenzene.

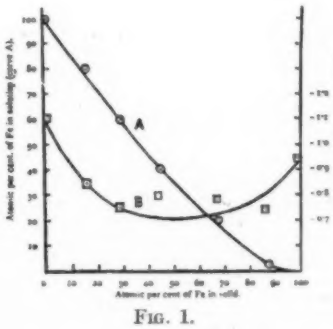


Fig. 1.

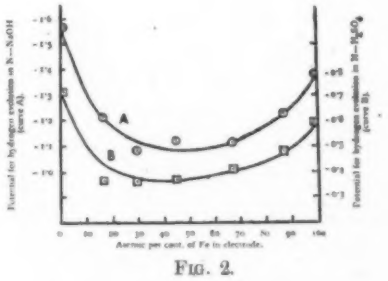


Fig. 2.

# PULVERISED FUEL AND EFFICIENT STEAM GENERATION.

## A Review of an I.E.E. Paper.

Mr. David Brownlie's paper on the above subject, which was read at the Mersey and North Wales (Liverpool) Centre of the Institution of Electrical Engineers on December 10th, at the London headquarters on the 13th inst., and is to be read in due course at eight of the other Centres, being illustrated with lantern slides, is a detailed consideration of the application of pulverised fuel for steam generation, as compared with mechanical stoking under the most modern conditions, more especially from the point of view of the "Lopulco" system for large water-tube boilers and the efficient generation of electricity in power stations. By the courtesy of Mr. W. R. Wood, of the Underfeed Stoker Co., Ltd., extensive data are given, some of which have not before been published, relating to the pioneer large pulverised-fuel-fired "Lakeside" electricity station at Milwaukee, together also with a description of the River Rouge power plant of the Ford Motor Co. at Dearborn, Detroit, using pulverised fuel and blast-furnace gas, which the author states is the most remarkable power plant in the world. For comparison, by the courtesy of Mr. R. B. Mitchell, there are given figures relating to mechanical stoking at the Dalmarnock electricity station, Glasgow, one of the most modern in Great Britain. A thorough consideration, based on actual results, of the advantages and disadvantages of pulverised fuel follows, and the paper contains numerous statistics.

One of the chief impressions to be gained from the paper is the urgent necessity for the adoption in Great Britain of scientific methods in connection with the production of cheaper power, and the limited application of pulverised coal to steam generation is cited as a striking example of the way we are said to be lagging behind the United States.

Based on his own investigations during 15 years into the operation of steam boilers in Great Britain, work which has included detailed investigation of the working of 400 different steam boiler plant installations, representing 1,513 boilers in 41 different industries with an annual coal bill of 3,250,000 tons, the author expresses the opinion that the average steam boiler plant efficiency throughout Great Britain is only 58 per cent. As a result also of the personal inspection of nearly 2,000 sets of boiler plant, equivalent to a consumption of 15,000,000 tons of coal per annum, his final conclusion is that the average efficiency with which 90,000,000 tons of coal is burnt per annum in the steam boilers of Great Britain is less than 60 per cent., representing an avoidable loss to this country of no less than 20,000,000 tons of coal per annum.

One of the chief difficulties attending the proper consideration of the subject is the fact that, according to the author, there is at present no satisfactory boiler testing code. What is supposed to be the British standard code, that of the Institution of Civil Engineers, is so antiquated that no one thinks of using it. The codes of the American Society of Mechanical Engineers and of the German Association of Engineers are both much better, but even they are not satisfactory, and the author suggests the formulation of a new international boiler-testing code, an outline of which he gives at length in his book on "Boiler Plant Testing." The absence of such a code tends to considerable confusion in expressing results, which may vary 2 or 3 per cent. on this account.

The general principles involved in the use of pulverised coal consist of crushing the coal and passing it over a magnetic separator to get rid of any iron particles. The crushed coal is then dried to 1 or 2 per cent. moisture, the latest type of "Lopulco" drier being a continuous small vertical installation using only the waste flue gases in the chimney base. The dry coal is then pulverised in ball mills, the latest average practice as regards fineness being that 90 per cent. will pass through a 100 mesh (100 holes to the linear inch, 10,000 holes to the square inch), and 65 per cent. through a 200 mesh. The pulverised coal is conveyed through troughs to bunkers, and then to "feeders," which mix the coal with 10 per cent. of the air required for combustion and deliver it to the burners, in which 90 per cent. of the air, preheated to a high temperature, is added. The result is an intensely hot flame of over 2,000 deg. F., complete combustion, 17-18 per cent. $CO_2$, no CO, and an entire absence of smoke.

The "Lopulco" system of pulverised fuel embodies, however, refinements and improvements which have made possible the success that has been obtained. The chief of these is said to be the water screen, a series of water-cooled 4-in. steel tubes in the bottom of the furnace, which prevents "slagging"—that is, the ash from becoming molten, an invention of the utmost importance. Also the brickwork is hollow, with cold air circulating through, and the resulting heated air at 300-700 deg. F. is used to supply the 90 per cent. of secondary air to the burners, already mentioned, thus resulting in high efficiency.

About 90 per cent. of the cement of the world is made with the aid of pulverised coal, and the present total consumption for all purposes in the United States and Canada, but particularly in the cement, iron and steel, and glass industries, is over 30,000,000 tons per annum. Little progress was, however, made with its application to steam generation in the United States until 1915, the real development commencing in 1920 with the Lakeside plant at Milwaukee.

At the present time, in America there are eight large sets of boiler plant working on the "Lopulco" system, with 43 water-tube boilers, having a total of 360,130 sq. ft. of heating surface; 300,000 sq. ft. is in constant operation, and conservative figures of 0.75 lb. of coal or 6.50 lb. of water per sq. ft. of heating surface per hour, representing 702,800 tons of coal per annum (7,000 hours), which is equivalent to 47 large standard British power-station boilers of 50,000 lb. evaporation per hour.

There are now under construction on the "Lopulco" system, 29 sets of plant comprising 91 boilers, including many of the largest water-tube boilers in the world, having a total heating surface of 1,405,230 sq. ft. Assuming, as before, conservative estimates, this equals a consumption of 2,695,300 tons of coal per annum—that is, 142 standard 50,000-lb. British power station water-tube boilers in constant operation. In less than six months from now 3,400,000 tons of pulverised coal will be burned per annum for steam generation, equal to half the capacity of the whole of the power stations of Great Britain put together, or 16 Dalmarnock stations. In fact, progress is so extraordinary, alike in the net working efficiency obtained, the size of individual boilers made possible, and the use of scientific control of the working of boiler plant, practically from a distant switchboard, that something like a revolution in steam practice has undoubtedly been effected.

In Great Britain, however, there has been practically no headway at all, and even at the present time there is only one large plant at work, that at the Hammersmith electricity station, with three boilers of 45,000 lb. evaporation, together with a small installation at Peterborough and one or two odd experimental boilers.

Previous to 1920, the ordinary admitted advantages of pulverised coal included higher boiler plant efficiency; complete combustion of the ash; the fuel is burned without moisture; convenience of transport in the boiler house; flexibility as regards different qualities of fuel burned; flexibility of the steam output of the boiler, as much as 100 per cent. overload being obtainable; reduced stand-by and banking losses; greater ease of scientific control; and reduced labour costs. The various diadvantages that have been stated against pulverised coal, such as excessive power consumption for the crushing, drying and pulverising operations; wear and tear and risk of breakdowns; deterioration of the furnace linings; damage to the boilers; danger of explosion and spontaneous combustion; troubles with the ash; and higher capital cost, as compared with mechanical stoking, are now proved—the author maintains—to be almost entirely erroneous in the case of modern plant.

The "Lakeside" plant at Milwaukee is designed for 160,000 kW normal working, or 200,000 kW overloaded, and the 40,000-kW boiler plant portion now running consists of eight "Edgemoor," 4-pass, water-tube boilers, working six, of 13,060 sq. ft. heating surface, with a normal evaporation of 90,000 lb. of water from and at 212 deg. F. per hour, or 115,000 lb. overload, equal to 4½ tons of pulverised coal per boiler per hour normal. The installation includes superheaters and cast-iron economisers, and works at 300 lb. gauge pressure with a "Lopulco" water screen on each boiler of 22 tubes 4 in. diameter, making 320 sq. ft. heating surface, and the plant is now being doubled in size.

The new plant now being erected at Vitry, the first large modern pulverised coal plant in Europe, consists of four "Ladd-Delaunay-Belleville" boilers of 16,678 sq. ft. heating surface with steel tube economisers of 9,684 sq. ft. heating surface, each boiler having also one "Lopulco" vertical coal drier, using the heat in the chimney gases only, one pulveriser, five "duplex" pulverised coal feeders, and ten "triplex" burners. The normal evaporation is 140,580 lb. of water from and at 212 deg. F. per hour, with an overload duty for four hours' duration of 210,870 lb. per hour, being 5.7 tons normal and 8.8 tons overload coal consumption per hour, at 12,600 B.th.u. The efficiency guarantee is 84 per cent., 10.98 lb. of water from and at 212 deg. F. per lb. of coal on normal load, or 10.76 lb. overload, equal to 8.4 lb. and 12.6 lb. of water per sq. ft. of heating surface per hour respectively. The total auxiliary power used is 18½ kWh per ton of coal, or 1 per cent. of the steam production.

The Dalmarnock station of the Corporation of Glasgow, which is designed for 200,000 kW, consists at present of 75,000 kW and 16 mechanically-stoked boilers (12 usually working when on full load) of 6,948 sq. ft. heating surface each, with 2,452 sq. ft. superheater and 5,155 sq. ft. economiser, working at 275 lb. pressure and 700 deg. F., with normal evaporation of 50,000 lb. from 150 deg. F. and 62,500 lb. overload.

In comparing the mass of data given, the author draws attention to the high efficiencies that are being obtained with pulverised coal. Lakeside is running regularly at 85-86 per cent. boiler plant efficiency, the most efficient station in the world, and 89 per cent. has been obtained on ordinary short tests. The loss of heat in the chimney base is only 8 per cent., the unburnt carbon in the ash about 0.5 per cent., and the excess air for combustion over the theoretical 10½-25 per cent. depending on the rating.

At the new Cahokia station, St. Louis, the figure is 85 per cent.; and at the Detroit Edison Trenton Channel station, with six enormous boilers of 29,000 sq. ft. heating surface, 86½-88 per cent., with 83 per cent. at the extraordinary overload of 13.8 lb. of water from and at 212 deg. F. evaporated per sq. ft. of heating surface per hour—that is, no less than 400,000 lb. of water per boiler per hour. In Great Britain, according to the author, 85 per cent. of the water-tube boiler plant is working at less than 70 per cent. efficiency, 10 per cent. at under 65 per cent., and less than 5 per cent. over 80 per cent. Amongst the finest long-duty performances with mechanical stokers are Dalmarnock (Glasgow), running 76.6 per cent. efficiency on 34 per cent. load factor, and probably 78.5 per cent. on 60 per cent. load factor, and in the United States the Connors Creek plant figure is 75 per cent., and at the Colfax power station 76.5-78.5 per cent., whilst the figure at Delaware is said to be 79.1-81.0 per cent. The best possible mechanical stoker long-duty practice is 81-82 per cent. efficiency, with 40 per cent. excess air. Pulverised coal, therefore, will give, say, 86 per cent. efficiency, and mechanical stoking 81.5 per cent., a saving of 5½ per cent. in the coal bill. Under normal conditions, however, mechanical stoker efficiency is only 75 per cent., so that the saving would be 12½ per cent., and if pulverised coal were used in most mechanically-fired stations, British or otherwise, the saving would be 15-20 per cent. in the coal bill.

The maintenance costs of pulverising plant are claimed to be actually less than those of mechanical stoking gear. The "Lakeside" plant, Milwaukee, for 15 months' running showed a cost of 1.17 pence per ton of coal for repairs to the plant and the "Lopulco" guarantee for the air-cooled brickwork is actually three years, which no mechanical stoker can equal. The danger of explosion and fire is not serious, and ash troubles also cause little difficulty. Careful tests at "Lakeside" show that 12-25 per cent. of the ash is blown out of the chimney top in an extremely fine state of division, 25-50 per cent. falls to the bottom of the combustion chamber, and 25-35 per cent. is caught in the chimney base. The labour costs with pulverised coal are approximately 20 per cent. less than with mechanical stoking. At the "Lakeside" plant, Milwaukee, several years' running shows a labour cost, in equivalent English money, of 1s. 3d. per ton, whereas at Dalmarnock, Glasgow, the figure is 1s. 7d. The total auxiliary power used for pulverised coal is now only 1 per cent. of the steam production of the plant. The figure for the very latest stoker performance is slightly less than 1 per cent., but the average is 2-3 per cent., and at Dalmarnock is 1.68 per cent. The unburnt material in the ash of pulverised coal is 0.40-0.75 per cent. carbon, whereas the best stoker figures are 2 per cent., with 3-5 per cent. for a large number of stations.

Also pulverised coal will burn in an extraordinary manner with other fuels, whether blast furnace gas, coke oven gas, oil, or pulverised coke, whilst the stand-by losses are considerably less with pulverised coal, and in the case of plant with long banking-up periods show a saving of 3-5 per cent. in the coal bill. The boilers are worked entirely from a distant switchboard by one attendant at the Ford plant, Detroit. It is difficult to obtain authentic figures for the capital cost, but roughly, there is not much difference between pulverised coal and mechanical stoking plant.

The author's considered opinion is that a serious investigation of the use of pulverised coal in Great Britain is imperative, especially for large power stations, and he thinks we shall eventually have to submit the greater part of our coal to low-temperature carbonisation, which incidentally would, he states, result in a national saving of at least £200,000,000 per annum, and render us independent of the rest of the world for motor spirit, fuel and Diesel oils, together with sulphate of ammonia for the proper cultivation of our soil, whilst the residual low-volatile fuel could be burnt in the pulverised condition at the highest efficiency.

### Discussion.

SIR JAMES H. R. KEMNAL, who opened the spirited discussion, thought the water screen a somewhat crude device from the boiler-maker's point of view. Their experiments with the "unit" system showed that there was no ash trouble, but the nature of the ash varied with the quality of coal burned. In this country a mechanical stoker much wider than 9 ft. could not be used, but in the U.S.A. they could use them over 34 ft. wide. The variety of coal that could be burned in the pulverised form was much more limited than in the case of the stoker, but he would not dispute the author's efficiency figures, although a few per cent. did not carry the weight it seemed to do at first sight. His point was: What did the kWh generated cost? The cost of the coal-pulverising plant was a vital factor, and in the case of a station like Dalmarnock it would probably be five or six times as great as the cost of mechanical stokers, and with the latter the same evaporation could be obtained as with pulverised fuel. Cast-iron economisers were quite unsuitable for the present common pressures. Pulverised fuel was a good proposition, but it was not everybody's business to use it or to make it a success.

MR. G. W. PARTRIDGE said that the use of pulverised fuel was worthy of the consideration of all engineers. In calculating his efficiency figures, the author had not taken into consideration to-day's stoker practice in this country. It was the cost of evaporation that mattered, and not efficiency; moreover, what was the capital cost of pulverising plant? American and English tests were not comparable, because the fuel used was not the same in both countries. In this country they must have a stoker that would burn any kind of fuel at a moderate cost. The throwing out of dust was one of the main difficulties of the pulverising system; it might be tolerated in America, but could not be allowed in London. Nevertheless, there were big future possibilities of using Kent coal in the powdered form.

Mr. B. POCHOBRADSKY pointed out that when considering what was better, more careful consideration must be given to what had already been done. The comparison set out in the paper was not a true one, because the increased efficiency indicated was not due to the use of pulverised coal at all, and he could prove it; it was due to other factors, such as the moisture content of the fuel, leaving temperature of the gases, amount of $CO_2$, &c. If certain corrections were made to the author's figures, it could be shown that the efficiencies were 88 per cent. at Dalmarnock and 87 per cent. at Lakeside, although the real figures were more like 82 and 82.9 per cent. respectively. It was true that pulverised fuel allowed the firing to be better controlled gave greater flexibility, and other advantages, but it could not be used universally, and there were cases in which it would show no advantage. The "unit" system would show a 3 per cent. efficiency gain over the central method of pulverising; moreover, the former was very much cheaper and would make it possible to burn poor fuel which the collieries could not at present sell at all. If they could do that, the collieries would in consequence be enabed to reduce the price of coal generally, and thus assist in the reduction of the cost of power production.

MR. DAVID WILSON asked why the author had introduced so much irrelevant matter into his paper as to make it unduly long. The author appeared to be a statistical rather than a combustion expert, and no doubt the American firm would appreciate the publicity it was getting through the paper. The speaker said he knew of a small railway generating station on the outskirts of London which was operating at an efficiency of 80 per cent., and stokers now gave such flexibility as to reduce stand-by losses very materially. At Birmingham they were burning coal of a calorific value of between 8,000 and 9,000 B.th.u., but they could obtain equally good results with coke breeze. Mechanical stokers would handle any sort of low-grade fuel, but the so-called low-grade coal used in the U.S.A. was nothing like so poor as the low-grade fuel met with in this country. The author's guarantees were given under test conditions, but there was a large difference between test figures and every-day operation; stoker makers could give similar high guarantees on test if they chose to do so. The ash percentages mentioned in the paper were very misleading, and although pulverised fuel must receive consideration, Americans were more ready to jump to conclusions than were English engineers.

Dr. LESSING, speaking as a chemist, pointed out that the ash content of coal was of the utmost importance, but it offered no bar to the pulverising system. Investigation had shown that the average coal contained only a small proportion of ash; most of the ash was quite extraneous, and it could and should be eliminated at the colliery. The benefit of such elimination was obvious, and would be covered by the advantages that would result in that the transport of unburnable matter would be reduced, ash-disposal problems would be simplified, and the erosion of powdered-coal burners and fire brick walls (which was a mechanical process) would be much reduced.

Mr. F. EVANS heartily welcomed the paper because of the grave difficulty encountered when attempting to deal, by means of mechanical stokers, with the 19 or 20 different classes of coal that might be met with in the same station. Pulverised fuel was bound to come to the fore, especially now that large turbines involving the use of big boilers were being installed. Mechanical stokers emitted a considerable amount of grit, but the stuff emitted from pulverised-fuel furnaces was very fine dust that settled in a form which was not objectionable, and would cause no one any trouble. Opposite the Ford plant were the offices of the city's medical officer, who thus had the best opportunity of observing the emission of grit and smoke, but he had found no cause to complain. Chain grates could be made wider than they were, but one of their very serious problems was that the ash plant installed must, in addition to handling the ashes, be capable of dealing with grate riddlings to the extent of 20 per cent. of the total coal burned.

Mr. W. M. MORDEY touched on the historical aspect of the subject.

Mr. J. S. ATKINSON regretted that the author had disposed of the "unit" system in a few lines; that type of plant was making more progress in Europe than in the U.S.A., and satisfactory machines were now available. They did not claim to obtain very much higher efficiency than could be got with

stokers, but they did claim to be able to burn lower grade, and, therefore, cheaper, fuels than stokers could handle.

Mr. DAVID BROWNLIE, in replying, said that so many points had been raised that he would have to reserve his full reply to them or publication in the *Journal*. In the paper he had not mentioned the capital cost of pulverising plant, because it was difficult to do so as the figures were influenced by so many factors that did not bear on the main point at issue; however, he would give figures if they were wanted. The water screen might or might not be a crude device, but it was effective. The "unit" system had been tried and tried again, and it could not do the job for boiler work; it was no use attempting to make one machine do several things at the same time and at one speed. Moreover, central control could not be employed with the "unit" system. If pulverised fuel was not a sound proposition, why were some of the largest and most efficient stations in the world discarding stokers and adopting it instead? It had passed the experimental stage, and in the U.S.A. they had years' experience, and were using millions of tons of coal in powdered form.

# RADIO SIGNAL FADING.

## An American Study.

DURING 1920 and 1921 the variations of intensity of received radio signals of high frequency, or short wave length, were studied by Messrs. J. H. Dellinger, L. E. Whittemore, and S. Kruse, of the Bureau of Standards of the Department of Commerce, U.S.A., the investigation being conducted with the assistance of the American Radio Relay League. During the tests from 5 to 10 stations transmitted signals in succession, which were received simultaneously at about 100 stations, whose operators were provided with forms for recording the variations noted. Particular attention was paid to signal intensity, fading, the prevalence of strays or atmospheric disturbances, and the weather conditions prevailing at the time of transmission. The reports received have been analysed and summary tables published* (from which the following details are abstracted) which indicate the possible relationships between the conditions existing during the tests.

Casual observation shows that fading is much more pronounced on short wave lengths, in fact, little is noticed on waves longer than 400 m. When it does occur on the longer wave lengths the variations are much less in amplitude and far less erratic than those which occur on the shorter wave lengths. Fading does not ordinarily take place within the daylight, or reliable, range of the transmitting station. It is primarily a phenomenon noted at long distances from the transmitter, and hence is more prevalent during the night time when transmission ranges are greatest. It was generally observed that the best recorders were, without exception, those who were accustomed to laboratory measurements. Singularly enough, the best radio operators were not generally good recorders, their curves being flat and lacking in detail, apparently because of the operator's tendency to concentrate his attention on the signal to the exclusion of all other sounds. He apparently follows the variations in signal strength without being aware that any variation is taking place.

The average distance of transmission was approximately 400 miles, with an input power not exceeding 1 kW in any case; an average of 26 observers stood watch every evening; on no occasion were less than 20 on duty, and over 500 usable records were included in the analysis.

Several characteristics of interest were obtained, although their importance is questionable. It was first noticed that similar curves occasionally occurred, and that the observers obtaining such curves might be widely separated geographically. Coincidently there also frequently occurred a "travelling curve"; that is, several curves are found which are similar in appearance, except that the variations in intensity occur at different times at the different stations. In general this effect seems to occur very haphazardly as regards the geographical distribution of the stations concerned, and therefore few, if any, conclusions can be drawn from their occurrence. Out of the 5,684 observations there were found 380 similar pairs of curves, including in this category the travelling curves. This represents only 6.7 per cent. of the total and, since such cases occurred very erratically, it is doubtful if there is anything more than an accidental connection between the curves. In the case of the first five pairs in this list the members of each pair are in the same general direction from the transmitting station. The sixth pair are at a wide angle apart relative to the transmitter, and the last pair are almost exactly at a 180 deg. angle, or in opposite directions from the transmitter. In addition, there were obtained during the same transmission 30 records which exhibited no common similarities. Many of these records were taken at points within a few miles of members of the pairs in the above lists, and yet these curves are entirely unlike those obtained by the other close-by observers. Another peculiar curve found occasionally is the "inverse curve," wherein the fluctuations in signal intensity are 180 deg. out of phase at two stations; that is, the curves are similar but opposite in sense. Of the 5,684 observations only 0.62 per cent. of inverse curves was found, and they are considered to be purely accidental in their occurrence.

The conclusions indicate that there is a tendency that the fading will be of a certain character under the given conditions. Of the 5,634 observations there were 990 cases of loud signals and 1,251 cases of weak signals, the remainder being of medium intensity. The relative occurrence of bad fading on the wave lengths 250 and 375 m. shows that the bad fading is more pronounced on the shorter wave lengths, but the shorter wave is slightly conducive to a greater percentage of loud signals. There is little difference in the intensity of strays or "static" on the 250 and 375-m. wave lengths.

A changing barometer at the transmitting station does not affect the fading. Fading is greater when the transmission takes place up or down the barometric gradient; no difference was noted in the fading between transmission up and transmission down the barometric gradient. Waves which travel along the isobars produce stronger signals than those travelling up or down the barometric gradient; no difference was found between transmission up and transmission down the barometric gradient. Transmission along the isotherms is slightly more conducive to stronger signals than when transmission is up or down the temperature gradient, and transmission along the isotherms tends toward less fading. Transmission along the isoabrs is slightly less conducive to fading than transmission along the isotherms.

Clouds at the transmitting station have no effect upon fading, but if it is generally cloudy at and between the transmitting and receiving stations, fading is more likely to be bad than when it is clear. Clouds at the transmitting station have no effect upon signal intensity, though clouds at the receiving station are conducive to stronger signals. Generally cloudy weather at and between the transmitting and receiving stations has no effect upon the signal strength, but clouds at the receiving station produce stronger strays.

In the total 1,251 cases of weak signals the percentage occurrence of various degrees of fading was as follows: Zero fading 4.6, slight 16.8, medium 29.2, bad slow 46, and bad fast fading 3.4 per cent. There is a tendency in weak signals to slow bad fading, but the presence of near-by wire lines has no effect upon fading.

In addition to these more general conclusions, interesting information was obtained when the locations of the transmitting stations were particularly considered. It may be concluded that effects near to the transmitting station contribute little to the fading characteristics at a distance, or at least do not similarly affect receiving stations scattered over a considerable area. Observers within a mile or two of each other may get entirely different curves when observing a distant transmitting station; also near-by observers obtained entirely different records of the transmission of the two special transmitting stations. In some cases the two sending stations were found to fade simultaneously, in other cases they seemed to be fading exactly inversely—that is, 180 deg. out of phase—and in still other cases the curves obtained by near-by recorders were entirely unlike. These observations lead to the conclusion that the cause of fading is of such a nature as to affect individually only small receiving areas.

Two special tests were conducted to investigate fading during the period of sunset. The curves obtained showed normal fading in every case, the only item of interest being the gradual increase in signal intensity as night came on. The special noon test was intended to contrast with the fading curves obtained at night. Unfortunately, very few curves were received and they were all from points within the daylight ranges of the stations and exhibited no fading. The third special test was for the purpose of locating the source of the very erratic fading of station 8XK at Pittsburgh, Pa. It showed definitely that the trouble was due entirely to tube blocking and was not true fading.

Several theories regarding radio-signal fading phenomena have been proposed. A preliminary discussion based on the results of this investigation was given by Messrs. Dellinger and Whittemore before the Philosophical Society of Washington on January 29th, 1921; and takes account of the presence of the Heaviside surface in the atmosphere 100 km. above the earth.

(i) The boundary of the Heaviside surface is not considered as absolutely horizontal, but as changing from time to time; the permanently ionised region above is the region of per-

*Scientific Paper No. 476 (Part of Vol. 19), Government printing office, Washington, U.S.A. Price 10 cents.

manent aurora and is so good a conductor that waves cannot penetrate it, so that any waves reaching it can only slide along it, just as waves slide along the even less perfectly conducting surface of the earth.

In daylight transmission the waves cannot reach the Heaviside surface because of the intervening ionised stratosphere, and hence only those waves which travel along the earth's surface are useful during the daytime. In travelling along the earth's surface the waves are diminished in intensity by absorption of their energy in the earth. At night, however, the waves may reach the Heaviside surface and travel and slide along it without appreciable absorption, which means that the waves travel enormous distances at night and short waves travel farther than long ones.

Because of the variable absorption which may be introduced by the irregularities of the Heaviside surface and the adjoining regions the waves may vary rapidly in intensity. Small irregularities would affect short waves more than long waves. These conclusions are in precise agreement with the facts.

Observations to date indicate that fading is greatest for waves within a certain range of wave lengths and is less for either longer or shorter waves. Fading is more pronounced at wave lengths in the neighbourhood of 250 m. than at longer waves, and transmission experiments using 100-m. waves indicate less severe fading than on 250 m. This may give an indication of the magnitude of the irregularities of the Heaviside surface.

The relation between the size of an obstructing or absorbing mass, or substance, and the wave length of the waves affected is illustrated by the fact that light waves are able to pass directly through a sufficiently thin sheet (0.00001 cm. thick) of any material. It is easier for a large mass of something to somewhat obstruct a 200-m. wave than a 2,000-m. wave.

If this theory be correct the maximum intensity received at night should be that given by the transmission formula with the absorption factor equal to unity, and tests recently reported by Nichols and Espenschied substantiate this theory. On a wave length between 350 and 400 m. the intensity of signals received at night was found to vary between two definite limiting values, *i.e.*, (1) that which would be obtained if the waves suffered no absorption, and (2) that which would be obtained with the absorption normally present in day-time transmission. This shows that the atmospheric absorption encountered by the waves at night varies from time to time between zero and the maximum absorption obtaining at any time, namely, the daylight value; that is, the part of the wave which travels up to the Heaviside surface may be unabsorbed or it may be totally absorbed, leaving, in the latter case, only the wave conducted along the ground as effective in transmitting signals.

Thus, while the transmission formula cannot predict the varying intensity of signals observed at night, it does give the limiting maximum value and, if the daytime value of the absorption coefficient is known for the particular region over which transmission takes place, it also gives a limiting minimum value. Within the distance from a transmitting station in which ground absorption is negligible there is no fading, and the day and night intensities are equal, since the waves are not affected by conditions in the upper atmosphere.

A preliminary statistical study of the transmission range of certain broadcasting stations which has been made since the work described above was done, indicates that at a distance of the order of 150 miles from the transmitting station a noticeable decrease is observed in the signal intensity, which increases again for greater distances. The distance at which this occurs varies with the wave frequency, which suggests that its explanation is associated with the variation of ground absorption with wave frequency, and that the signals received at distances beyond this minimum point are due to the propagation along the Heaviside surface.

(*ii*) Another theory of fading, proposed by Mr. Kruse, was discussed at the Radio Club of America on September 24th, 1920, and is based upon the principle of the production of interference bands in the vicinity of the receiving station by the reflection of the waves from any reflecting surface, such as a cloud or fog bank or from the Heaviside surface or other ionised surface. The movement of this reflecting surface or series of surfaces would result in the movement of the interference bands at the receiving station and the production of the fading phenomenon. Cloud and fog banks would be expected to reflect short waves more than long waves, since such banks are more nearly comparable in size with the shorter wave lengths.

(*iii*) Other theories have been proposed, the majority agreeing in principle with those above described. It has been suggested that fading may be influenced by changes in the direction from which the waves arrive at a receiving station, and consequently a highly directional receiving antenna would experience an apparent fading of signals due to direction changes that a non-directional receiving antenna would not. Experiments conducted at Anacostia, Washington, and Chicago during the fading tests indicate that direction changes of the short waves are negligible, however, and that they do not enter into the causes of fading.

## EXPORTS AND IMPORTS OF ELECTRICAL GOODS AND MACHINERY IN NOVEMBER, 1923.

The electrical exports during the month of November showed a decrease of £37,983 from the October total, reductions being noted in all sections with the exception of those for batteries and accumulators and electrical machinery. The month's total is, however, £195,502 in excess of that for November, 1922, in spite of the adjustment in prices.

The electrical export totals for the first eleven months of 1922 and 1923 were:—

| Exports | 1922. | 1923. |
|---|---|---|
| Electrical goods and apparatus ... | £6,732,218 | £7,595,213 |
| Electrical machinery ... ... | 3,824,786 | 3,539,204 |
| | £10,557,004 | £11,134,417 |

In the electrical imports section an increase of £6,425 is noted as compared with the previous month's total and an increase of £87,665 as compared with November, 1922.

The electrical import figures for the first eleven months of 1922 and 1923 were: —

| Imports | 1922. | 1923. |
|---|---|---|
| Electrical goods and apparatus ... | £1,348,660 | £2,153,136 |
| Electrical machinery ... ... | 1,100,297 | 935,970 |
| | £2,448,957 | £3,089,106 |

The re-export total was £5,767 higher than in the previous month and £10,681 more than in November, 1923. The principal increases occurred in the electrical machinery section. There was an increase of £4,245 in re-exports during the past eleven months:—

| | Exports. | | | Imports. | | | Re-Exports. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Electrical exports for Nov. 1923. | Inc. or dec. as compared with Oct., 1923. | Inc. or dec. as compared with Nov., 1922. | Electrical imports for Nov., 1923. | Inc. or dec. as compared with Oct., 1923. | Inc. or dec. as compared with Nov., 1922. | Electrical re-exports for Nov., 1923. | Inc. or dec. as compared with Oct., 1923. | Inc. or dec. as compared with Nov., 1922. |
| Electrical goods and apparatus (unenumerated) ... ... | £161,625 | − £16,671 | + £38,352 | £87,555 | + £6,399 | + £34,761 | £4,686 | − £15 | + £2,074 |
| Insulated wires and cables ... | 199,434 | − 17,514 | + 19,987 | 24,800 | − 9,587 | + 7,618 | 50 | − 101 | + 50 |
| Glow lamps ... ... ... | 25,162 | − 14,950 | − 3,073 | 25,495 | − 6,278 | − 3,195 | 365 | − 329 | − 51 |
| Arc lamps and parts ... ... | 983 | − 150 | − 337 | 1,193 | + 327 | − 62 | 461 | + 213 | + 461 |
| Batteries and accumulators ... | 62,030 | + 12,638 | + 29,080 | 18,977 | + 2,077 | + 1,178 | 580 | − 468 | − 1,490 |
| Meters and instruments ... | 32,997 | − 3,456 | + 60 | 16,311 | + 9,095 | + 9,974 | 562 | + 182 | + 456 |
| Carbons ... ... ... ... | 4,866 | − 7,029 | + 1,899 | 15,055 | + 4,960 | + 8,025 | 365 | + 335 | + 160 |
| *Electrical Machinery—* | | | | | | | | | |
| Electrical machinery (unenumerated) ... ... ... | 187,589 | + 21,357 | + 49,993 | 81,232 | + 6,223 | + 8,693 | 15,360 | + 8,339 | + 9,177 |
| Railway and tramway motors | 36,412 | + 1,271 | + 21,819 | — | — | — | — | — | — |
| Other motors and generators ... | 192,853 | + 49,692 | + 48,621 | — | — | — | — | — | — |
| Switchboards (not telegraph or telephone)... ... ... | 5,479 | − 2,204 | − 5,211 | — | — | − 4 | — | — | — |
| *Telegraph and Telephone Cable and Material—* | | | | | | | | | |
| Telegraph and telephone wires and cable (not submarine) | 55,328 | − 45,683 | + 28,003 | 9,377 | + 1,661 | + 4,704 | 33 | − 139 | + 33 |
| Submarine telegraph and telephone cable ... ... ... | 18,242 | + 3,769 | − 33,013 | — | — | — | — | — | — |
| Telegraph and telephone instruments and apparatus ... | 156,576 | − 19,053 | − 678 | 57,852 | − 8,452 | + 15,973 | 574 | − 2,250 | − 188 |
| Totals ... ... ... | £1,139,576 | − £37,983 | + £195,502 | £337,847 | + £6,425 | + £87,665 | £23,036 | + £5,767 | + £10,681 |
| Increase or decrease for the eleven months ended November, 1923. | | Exports. + £577,413 | | | Imports. + £640,149 | | | Re-exports. + 4,245 | |

## NEW PATENTS APPLIED FOR, 1923.

**(NOT YET PUBLISHED.)**

Compiled expressly for this journal by MESSRS. SEPTON-JONES, O'DELL AND STEPHENS, Patent Agents, 285, High Holborn, London, W.C.1.

The name of the applicant's patent agent, if any, will be found on the printed specification.

30,324. "Commutator for motor engines." H. Dinsdale. December 3rd.
30,340. "Telegraph keyboard perforator." A. S. Willmot. December 3rd.
30,342. "Adjustable holder for candles, electric lamps, &c." J. Grove. December 3rd.
30,343. "Variometers." G. Pelletier. December 3rd. (France, December 1st, 1922.)
30,355. "Transmitting photographs, messages, &c., by telegraphy." C. E. Mayer. December 3rd.
30,364. "Lighting emergency electric lamps on failure of main current." G. Isenthal. December 3rd.
30,365. "Volt-ampere meters." E. W. Moss (Lincoln Meter Co., Ltd.). December 3rd.
30,371. "Light for interior of taxi-cabs, &c." Yellow Cab Manufacturing Co. of England, Ltd. December 3rd.
30,372. "Illuminated indicator for taxi-cabs, &c." Yellow Cab Manufacturing Co. of England, Ltd. December 3rd.
30,374. "Rectifiers or detectors for wireless telegraphy, &c." H. G. B. Corby, S. Croneen, F. C. R. Holland, and A. E. Katz. December 3rd.
30,383. "Telephone systems and apparatus." Automatic Telephone Manufacturing Co., Ltd., and J. E. Ostline. December 3rd.
30,391. "High-frequency telephone systems." Ges. für Drahtlose Telegraphie. December 3rd. (Germany, December 2nd, 1922.)
30,400. "Method of manufacturing magnet cores." Felten & Guilleaume Carlswerk Akt. Ges. December 3rd. (Germany, December 5th, 1922.)
30,404. "Arrangement for determining direction of sound." Signal Ges. December 3rd. (Germany, December 4th, 1922.)
30,411. "Wireless generators." F. L. Hollister. December 3rd.
30,415. "Manufacture of electric resistances." L. Verhaert. December 3rd. (France, December 14th, 1922.)
30,417. "Telephone systems." Automatic Telephone Manufacturing Co., Ltd. (Automatic Electric Co.). December 3rd.
30,443. "Loud-speaking telephones." A. Hippisley. December 4th.
30,450. "Contact devices for engine ignition apparatus." H. S. Budge and H. Knowlson. December 4th.
30,453. "Variable condensers." J. F. Easton. December 4th.
30,464. "Telephone percussion absorber." E. D. Young. December 4th.
30,479. "Electromagnets." T. Stretton and Thor Electric Safety Lamp Co., Ltd. December 4th.
30,482. "Telephone systems." J. E. Collyer and Coventry Automatic Telephones, Ltd. December 4th.
30,499. "Receiving systems for electric currents and electromagnetic waves." Marrec, Ltd., and Y. Marrec. December 4th.
30,511. "Magneto or dynamo-electric exploders." J. D. Morgan and Sir F. L. Nathan. December 4th.
30,519. "Method of balancing telephone phantom lines for reducing overhearing." Felten & Guilleaume Carlswerk Akt. Ges. December 4th. (Germany, December 4th, 1922.)
30,523. "Regulators for electric discharges." British Thomson-Houston Co., Ltd. December 4th. (United States, January 30th.)
30,524. "Regulating electric distribution systems." British Thomson-Houston Co., Ltd. December 4th. (United States, January 30th.)
30,528. "Impulse-repeating arrangements for telephone, &c., systems." H. Adams and Automatic Telephone Manufacturing Co., Ltd. December 4th.
30,543. "Terminal for connecting telephone, &c., wires." H. L. Percy. December 5th.
30,548. "Connectors for wireless telephones." J. Judge. December 5th.
30,561. "Electric ceiling roses." C. Buckley. December 5th.
30,572. "Automatic, &c., telephone systems." J. E. Collyer and Coventry Automatic Telephones, Ltd. December 5th.
30,573. "Locking devices for electric incandescent lamps." J. Dooley and G. J. Parnell. December 5th.
30,601. "Buzzer device for audible signalling." R. J. Farrar. December 5th.
30,624. "Casings for electric regulators, &c." R. H. Barbour and J. R. Walton. December 5th.
30,627. "Electrically-illuminated advertising signs, &c." W. H. Gwynn. December 5th.
30,628. "Electric contact devices." C. O. Alexander, C. B. Johnson, and T. W. Simpson. December 5th.
30,629. "Electric terminals." C. O. Alexander, C. B. Johnson, and T. W. Simpson. December 5th.
30,636. "Rheostats for wireless receiving sets, &c." Gramophone Co., Ltd., and B. E. G. Mittell. December 5th.
30,637. "Controls for wireless receiving sets, &c." Gramophone Co., Ltd., and B. E. G. Mittell. December 5th.
30,638. "Rheostats for wireless receiving sets, &c." Gramophone Co., Ltd., and B. E. G. Mittell. December 5th.
30,639. "Means of mounting basket coils for wireless apparatus." Gramophone Co., Ltd., and B. E. G. Mittell. December 5th.
30,654. "Crystal detectors." M. A. Robinson. December 6th.
30,659. "Transformers for radio-frequency currents." J. P. Jayne. December 6th.
30,683. "Wireless apparatus." J. B. Johnston. December 6th.
30,704. "Loud-speaking telephone receivers." Western Electric Co., Ltd. (Western Electric Co., Inc.). December 6th.
30,705. "Radio-receiving sets." B. B. Grace and Western Electric Co., Ltd. December 6th.
30,708. "Coil holder, &c." R. H. Winter. December 6th.
30,709. "Adaptor socket for valves of wireless sets." R. H. Winter. December 6th.
30,712. "Variable condenser." J. E. Dawson. December 6th.
30,713. "Electric storage batteries." J. F. Monnot. December 6th.
30,723. "Maximum-current interrupter." A. Woosnam (Herkules Akt. Ges. für Fabrikation und Handel). December 6th.
30,736. "Automatic calling apparatus for telephonic installations." New Antwerp Telephone and Electrical Works Soc. Anon. December 6th. (Belgium, December 14th, 1922.)
30,738. "Mountings for thermionic valves." W. M. Holbeach, T. D. Ward-Miller, and Sterling Telephone and Electric Co., Ltd. December 6th.
30,741. "Electron discharge devices." S. Ruben. December 6th.
30,742. "Electricity meters, &c." A. E. White (Sangamo Electric Co.). December 6th.
30,746. "Electric accumulators, &c." H. F. Joel. December 6th.
30,764. "High-tension magnetos." M-L. Magneto Syndicate, Ltd., and E. A. Watson. December 7th.
30,772. "Appliance for supporting wireless aerials." W. Edwards. December 7th.
30,780. "Electric multi-core cables." British Insulated & Helsby Cables, Ltd., and A. H. Selwyn. December 7th.
30,787. "Electric couplers, connectors, &c." A. Rogers. December 7th.
30,788. "Electric couplers, connectors, &c." A. Rogers. December 7th.
30,793. "Lead sleeve cable joints." British Insulated & Helsby Cables, Ltd., and B. Welbourn. December 7th.
30,796. "Incandescent electric lamps." C. V. Treleaven. December 7th.
30,813. "Terminal socket and plug connector for electric circuits." E. B. Doteslo. December 7th.
30,823. "Electric relays." Metropolitan-Vickers Electrical Co., Ltd., T. W. Ross, and C. Ryder. December 7th.
30,824. "Electric relays." Metropolitan-Vickers Electrical Co., Ltd., T. W. Ross, and C. Ryder. December 7th.
30,826. "Prepayment electricity meters." G. Sanders. December 7th.
30,827. "Electrolytic electricity meters." B. North and H. D. B. North. December 7th.
30,843. "Telephonic receiving apparatus." J. Bethenod. December 7th.
30,845. "Electric transformers." British Thomson-Houston Co., Ltd. (General Electric Co.). December 7th.
30,846. "X-ray apparatus, &c." British Thomson-Houston Co., Ltd. (General Electric Co.). December 7th.
30,849. "Electric heaters." I. Guiducci. December 7th.
30,851. "Electric switches." A. L. Weekes. December 7th.
30,859. "Arrangements for mounting electric motors, &c." English Electric Co., Ltd., and R. H. Holbeche. December 7th.
30,866. "Induction electricity meter." C. E. J. Brandt, R. M. Fichter, and E. A. Fouilleret. December 8th. (France, March 20th.)
30,881. "Railless roadway for electric vehicles." E. Belloni. December 8th. (Italy, December 9th, 1922.)
30,884. "Electric testing apparatus for fluid-pressure engines." Highfield Electrical Co., Ltd., F. W. Highfield, and H. E. Taylor. December 8th.
30,894. "Variable electric inductances." R. G. Cave. December 8th.

## PUBLISHED SPECIFICATIONS.

The numbers in parentheses are those under which the specification will be printed and abridged, and all subsequent proceedings will be taken.

### 1922.

17,384. "Devices for protecting conductors of electric machines against losses due to eddy currents." T. Lehmann. June 23rd, 1921. (182,125.)
19,595. "Automatic telephone system and switching apparatus therefor." H. Baron (F. Aldendorff). July 17th, 1922. (Addition to 181,826.) (207,219.)
20,012. "Gramophones and like sound-reproducing machines and telephone loud-speakers." C. H. Verity. July 21st, 1922. (Cognate applications Nos. 21,040/22 and 22,892/22.) (207,222.)
22,162. "Switchgear for starting and controlling electric motors." J. A. Hirst and Brook, Hirst & Co., Ltd. August 15th, 1922. (207,232.)
22,314. "Telephone receivers." T. L. Jones. August 16th, 1922. (207,234.)
22,967. "Process of, and apparatus for, producing electrical discharges in vacuum tubes." C. Deguisne and F. Dessauer. August 23rd, 1922. (207,262.)
23,008. "Electric burglar and like alarms." E. R. Smith. August 24th, 1922. (207,263.)
23,023. "Wireless transmission by thermionic vacuum tubes." L. G. Preston, G. Shearing, and E. J. Grainer. August 24th, 1922. (207,265.)
23,024. "Generation of high-frequency alternating currents by means of thermionic vacuum tubes, and wireless telegraphic and telephonic signalling therewith." L. G. Preston and N. Shuttleworth. August 24th, 1922. (207,266.)
24,505. "Calibration of electrical apparatus." N. Lea and Radio Communication Co., Ltd. September 9th, 1922. (207,292.)
25,051. "High-frequency signalling systems." British Thomson-Houston Co., Ltd. September 17th, 1921. (186,069.)
25,713. "Alternating electric current motors." British Thomson-Houston Co., Ltd. (General Electric Co.). September 22nd, 1922. (207,309.)
25,792. "Miners' safety and other electrical lamps." G. Oldham and J. Oldham. September 23rd, 1922. (207,312.)
26,852. "Combined electric and gas lamps." G. F. Dobinson. October 4th, 1922. (207,320.)
27,029. "Mechanism for controlling the carburettor and ignition apparatus of motor-cars, motor-boats, aircraft, and the like." S. H. Attwood and Ruston & Hornsby, Ltd. October 6th, 1922. (207,321.)
27,158. "Electric switch." J. E. J. Whitaker and M. C. Richardson. October 7th, 1922. (207,324.)
27,490. "Crystal detectors for use with wireless apparatus." W. C. J. Schlie. October 11th, 1922. (207,328.)
27,866. "Rheostats for electrical purposes." H. Saville and C. H. Thornton. October 14th, 1922. (207,335.)
28,687. "Electric relays." T. W. Ross and Metropolitan-Vickers Electrical Co., Ltd. October 21st, 1922. (207,347.)
28,907. "Incandescent electric lamp." W. J. Cameron. October 24th, 1922. (207,351.)
29,520. "Multiplex telegraph systems." Automatic Telephone Manufacturing Co., Ltd., and H. H. Harrison. October 28th, 1922. (207,354.)
30,372. "Electric switches." W. Preston. November 7th, 1922. (207,363.)
31,028. "Method of manufacture of electric glowlamp bulbs." A. M. Monnier. June 29th, 1922. (200,050.)
31,779. "Radio-frequency electron tube amplifiers." A. J. H. Haddan (Radio Instrument Co., Inc.). November 21st, 1922. (207,373.)
32,038. "Sound-reproducing mechanism." F. B. Mitchell. July 20th, 1922. (Divided application 19,904/22.) (207,374.)
33,062. "Switching apparatus for use in telephone or like systems." Siemens & Halske Akt. Ges. December 3rd, 1921. (189,806.)
33,466. "Selectors for party-line telephone installations." L. d'Haenens. December 9th, 1921. (190,163.)
33,684. "Variable electric condensers." L. N. Hall. December 9th, 1922. (207,391.)
33,604. "Electrical devices for controlling the flow of liquids." A. G. Jackson. December 9th, 1922. (207,392.)
33,874. "Brake gear for vehicles, specially applicable to tramcars." J. W. Thorpe. December 12th, 1922. (207,393.)
35,337. "Method of, and means for, feeding electric furnaces with current." L. Quattrino. December 29th, 1921. (191,067.)

### 1923.

1,035. "Electric switches for printing presses and the like." British Thomson-Houston Co., Ltd. (General Electric Co.). January 11th, 1923. (207,418.)
6,406. "Power plant for operating electrically-driven machinery." P. Luth and Deutsche Solvay-Werke Akt. Ges. March 6th, 1923. (207,445.)
6,616. "Long-distance telephony." B. E. D. Kilburn (Naamlooze-Vennootschap de Nederlandsche Thermo-Telephoon Maatschappij). March 7th, 1923. (207,449.)
6,617. "Long-distance telephony." B. E. D. Kilburn (Naamlooze Vennootschap de Nederlandsche Thermo-Telephoon Maatschappij). March 7th, 1923. (207,450.)
7,381. "Electric hand iron." Metropolitan-Vickers Electrical Co., Ltd. March 23rd, 1922. (195,370.)
8,991. "Ventilation of dynamo-electric machines." Metropolitan-Vickers Electrical Co., Ltd. April 13th, 1922. (196,268.)
9,579. "Moving electric signs." F. C. Reilly. April 7th, 1923. (207,469.)
10,136. "Variable electrical condensers." W. Dubilier. September 16th, 1922. (204,010.)
11,874. "Electric motor controllers." A. H. Curtis, A. H. Mackley, and Igranic Electric Co., Ltd. May 2nd, 1923. (207,477.)
18,632. "Telephone receivers." A. Orling. October 18th, 1922. (Divided application, 21,794/22. Addition to 21,794/22.) (207,480.)
21,747. "Driving mechanism for electric locomotives." Metropolitan-Vickers Electrical Co., Ltd. September 16th, 1922. (204,033.)
22,745. "Sparking plugs." W. W. Markland. September 10th, 1923. (207,482.)
25,944. "Automatic telephone system, and switching apparatus therefor." H. Baron (F. Aldendorff). July 17th, 1922. (Divided application on 19,595/22. Addition to 189,841.) (207,483.)
25,945. "Automatic telephone system, and switching apparatus therefor." H. Baron (F. Aldendorff). July 17th, 1922. (Addition to 181,826. Divided application on 19,595/22.) (207,484.)
26,651. "Machines for winding electric coils." E. W. Patterson (Dictograph Products Corporation). July 27th, 1922. (Divided application on 20,528/22.) (207,485.)